

**Preserved Larval and Small-Fish Collections
of the Upper Colorado River Basin:
Maintenance and Cataloging of a Valuable Historical Database**

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by

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List of Key Words

Upper Colorado River Basin	collection maintenance
larval fish	collection management
juvenile fish	collection catalog
small fish	curation

Executive Summary

Most Recovery Implementation Program (RIP) participants recognize the importance of their preserved Upper Colorado River Basin (UCRB) collections as voucher for program investigations and as long-term sources of additional biological and historical information. The Larval Fish Laboratory (LFL) at Colorado State University serves as a repository for many of the preserved fish eggs, larvae, small juveniles, and small adults collected by RIP agencies. LFL holdings now include over 58,000 UCRB taxon-specific lots and an estimated 2.8 million specimens, some collected as early as 1976.

The objectives of this 3-year (1992-1994), \$60,000 project were to provide for the proper care and management, improved accessibility, and permanency of UCRB larval and small fish collections held by LFL. Those objectives have been achieved for nearly half the UCRB collections, except collection permanency which continues to be pursued outside the scope of this project. Accomplishments include: (1) licensing and implementing a version of the NSF-sponsored MUSE (museum) computer catalog and collection management system; (2) cataloging, upgrading (containers and preservative as necessary), and reorganizing 24,840 lots of UCRB collections (1.2 million specimens); (3) establishing procedures and policies for collection management and use; (4) arranging for on-line computer access to catalog data; and (5) estimating time and costs for completing the task of cataloging and handling backlog collections.

This project has successfully cataloged, upgraded, and reorganized nearly half (43%) of the UCRB collections currently held by LFL on behalf of RIP participants. However, approximately 33,360 lots collected since 1976 remain uncataloged backlog. Time and labor and materials costs for finishing the task are estimated at 1.9 man-years and \$65,960. Additional shelving will also be required to accommodate yet-to-be-processed 1994, 1995, and future collections. For deposited collections processed by LFL, most 1994 and 1995 and all future collections have been or will be cataloged as part of collection processing. We recommend that RIP support upgraded care and cataloging for the remaining backlog of UCRB collections, expansion of collection shelving, and on-going curation of preserved fish collections.

Introduction

Importance of Maintaining Preserved Collections

Biological specimens are sometimes inadvertently or necessarily killed in the course of monitoring or research investigations. Many biologists believe it is their ethical and scientific responsibility to maximize the value and usefulness of sacrificed specimens beyond their own immediate needs. This obligation can be met by properly preserving those specimens and arranging for their long-term or permanent care in an appropriate repository where they may remain available to the public for future research, reference, or educational purposes.

Properly preserved, catalogued and maintained collections are a valuable historical resource. We cannot go back in time and collect them again. They are the ultimate, physical database for verification of recorded data; they are voucher for specimen identity, numbers, condition, lengths, and other specimen-based information. As emphasized in an Association of Systematics Collections promotional leaflet a few years ago, "labwork and fieldwork without voucher specimens is always questionable." Preserved specimens are the only means for updating or refining previously recorded data such as length frequencies requiring smaller size intervals or specimen identities based on new and better means for diagnosis (e.g., new criteria for more accurately distinguishing razorback sucker *Xyrauchen texanus* and longnose sucker *Catostomus catostomus* larvae from other catostomids, humpback chub *Gila cypha* from roundtail chub *G. robusta*, or very small sand shiner *Notropis stramineus* larvae from red shiner *Cyprinella lutrensis*). Future systematics investigations might reveal that species X is actually two or more sympatric species. A taxonomic reassessment of species X in past collections might only be possible if those specimens remain available. Preserved collections are an irreplaceable reservoir of largely untapped information such as age and physical condition, morphological anomalies, parasitism, presence of toxic substances, food habits, reproductive and developmental life history, and systematics information. In many cases, preserved collections preclude the need for new collections and the associated costs in time and funds.

Most Recovery Implementation Program (RIP) participants recognize the continuing value of their preserved collections. Through permit and policy requirements for deposition of preserved specimens in an appropriate museum or alternative repository and expanded support for the proper care and management of those deposited collections, RIP can ensure the long-term availability of its preserved collections, both as voucher for participant investigations and as a long-term source for additional biological and historical information. In most cases, the additional costs to RIP for ensuring the long-term care and availability of preserved Upper Colorado River Basin (UCRB) collections is just a small percentage of the cost for their collection, preservation, and processing. For example, if the latter costs are greater than \$100 per collection (as is often the case), cataloging and initial maintenance costs for those collections are less than 10% (see section on Cataloging Time and Costs); subsequent on-going maintenance costs per collection are minimal.

Larval Fish Laboratory and Upper Colorado River Basin Collections

The Larval Fish Laboratory (LFL) at Colorado State University was established in fall 1978 within the College of Natural Resources and Department of Fishery and Wildlife

Biology as a largely self-supporting entity relying on contracts, service fees, and grants. Its mission is to advance knowledge of the taxonomy, life history, and ecology of fishes in North America's freshwaters through research, service, and education, with emphasis on the early life stages. To this end, it also serves as an informal repository for the preserved early life stages of fishes collected throughout North America. However, most LFL research and service has been conducted as a participant in the effort to monitor and recover rare and endangered fishes of the UCRB. Accordingly, the vast majority of LFL's holdings have been deposited by state and federal agencies, environmental consulting firms, and university researchers associated with that effort. As of 1995, LFL held over 58,000 taxon-specific lots from UCRB collections, an estimated 2.8 million specimens, some collected as early as 1976. (Lots are single-species or higher-taxon batches of specimens, sometimes individuals, from a specific collection or source). Since 1992, LFL holdings have been growing by over 3,200 lots and 240,000 specimens per year.

Collections of larger UCRB fishes are usually processed in the field and returned alive near their point of collection, a practice not feasible for most collections of larval and early juvenile fishes. The relatively few larger fishes that have been preserved were occasionally deposited with the National Biological Service's (NBS) Western Biological Surveys Collections or its predecessor, the U.S. Fish and Wildlife Service Field Station Collections (BS/FC) in Fort Collins, Colorado. The Western Biological Surveys Collections have been relocated, in part, from Fort Collins to the Museum of Southwestern Biology (MSB) at the University of New Mexico, Albuquerque, but remain under the administrative authority of the renamed Midcontinental Ecological Science Center in Fort Collins. As of this report, the fish, amphibian, and reptile portions of the Western Biological Surveys Collections remain in Fort Collins. Transfer to MSB has been delayed a year or two until MSB moves to new facilities, at which time the fish portion of the collection is supposed to be integrated with MSB's ichthyological collection which already includes much material from the Colorado River Basin, some dating back to the early 1960s (S. P. Platania, MSB, personal communication).

Prior to this project, collections deposited with LFL were shelved and minimally maintained (checked annually for fluid levels) on a mostly gratis basis, but the steady growth of this collection precluded continued unfunded curation. The Larval Fish Laboratory has been willing to continue to serve as a repository for UCRB larval and small fish collections but requires adequate funds for their proper organization, cataloging, and on-going care. The cost to catalog, maintain, and provide ready access to these collections is relatively small considering the time and funds already invested in their collection and processing. Proper cataloging and care are also essential if collections are to be eventually integrated with or transferred to a permanent museum.

Relationship to Recovery Implementation Program Recovery Action Plan

This project is related to RIPRAP (Recovery Implementation Program Recovery Action Plan) General Recovery Program Support Task V—"Monitor populations and habitat and conduct research to support recovery actions, research, monitoring, and data management"—and, if preserved specimens are considered data, specifically Task V.A.2—"Conduct interagency data management program to compile, manage, and maintain all research and monitoring data collected by the Recovery Program." As voucher and physical resources for additional information, preserved UCRB collections are the

foundation for much RIP research and management. This includes work on endangered species production, non-native species, flow manipulation, and habitat creation or modification. Accordingly, the importance of preserved collections to RIP warrants recognition as a specific RIPRAP General Recovery Program Support task—to "provide for long-term care, cataloging, and accessibility of preserved collections as voucher for Recovery Implementation Program research and as a resource for additional biological and natural history information."

This project was funded under RIP for years 1992 through 1994 with a budget of \$10,000 the first year and \$25,000 the second and third years. The project was extended without additional funds through September 1995. Due date for this final report was extended through January 1996.

Objectives

Project objectives were to provide for the proper care and management, improved accessibility, and permanency of UCRB larval and small fish collections held by LFL.

Methods

- Consider alternative computer programs for cataloging and managing LFL larval and small fish holdings and consult on same with the curator (M. A. Bogan) and collection manager (C. A. Ramotnik) of the U.S. Fish and Wildlife Service Field Station Collections (National Ecology Research Center, Fort Collins) which serves as a repository for larger fishes collected in the UCRB. (The Field Station Collections are now the NBS Western Biological Surveys Collections in Albuquerque).
- Select and configure IBM-compatible computer with adequate memory and data storage, appropriate software, and a laser printer to accommodate the selected catalog and collection management program, host a local network with existing LFL computers as interactive workstations, and facilitate on-line access and communications.
- Acquire, configure, learn, and maintain the selected collection management program.
- Seek and arrange for electronic (or on disk) transfer of needed collection information from the agencies or firms that deposited collections.
- Catalog, rebottle if necessary, replace or top-off preservative, relabel, and reorganize on shelves as many sets of collections as time and funds under this proposal will allow.
- Establish on-line access to the collection catalog and related communications by installation of appropriate computer hardware and software and either a dedicated telephone line or connection to the university's "backbone" network.
- Ensure collection permanency, if feasible, by establishing a formal link with the U.S. Fish and Wildlife Service Field Station Collections (now NBS Western Biological Surveys Collections) or another permanent collection or museum.
- Establish and prepare a manual on standard procedures and policies for management and use of the LFL Collection.
- Document the time required to catalog, upgrade, and reorganize collections and estimate costs and time required to finish the task for any backlog of UCRB collections remaining after this project; also, estimate cost to incorporate cataloging as part of procedures for processing new collections (specimen identification, counts, and length frequencies).

Results (Findings)

Selection of a Computer Collection-Catalog and Management Program

Before and during the first year of this project, I consulted with the curator and collections manager of the U.S. Fish and Wildlife Service Field Station regarding their cataloging system and advice on computer cataloging programs. However, their fish collections, including those from the UCRB, were still being cataloged by hand. After reviewing alternatives, we adopted the MUSE program and hoped that the Field Station might do likewise to facilitate integration of our respective catalogs. They have since, as the NBS Western Biological Surveys Collections, entered their fish catalog data in a Reflex database similar to that used for other collection taxa. Eventually their collection will be physically integrated and computer-cataloged with MSB collections, although they will remain federal government property (M. A. Bogan, NBS, personal communication). MSB developed their own computer catalog and collection management system based on the Paradox relational database program.

MUSE is not just a relational cataloging database, but a network-compatible, collection-management system, including integrated provisions for recording and tracking loans, exchanges, and deaccessions (Humphries 1994). With National Science Foundation support, MUSE was originally developed for ichthyological collections by J. Humphries (Cornell University) on the Btrieve database engine, but it has since been adapted for a wide range of museum collections from vertebrates in general to mammals, birds, herps, invertebrates, and even a botanical collection (Appendix I). MUSE is licensed for over 80 museum and research collections in North America, South America, and overseas, including many of the more widely recognized fish and herpetological collections. Although MUSE is customized to the special needs of each individual collection, all versions are based on a standardized database model. This allows collection catalogs that have been linked to a MUSEServer to be searched individually or simultaneously from any computer connected to the Internet (see On-line Searches below).

MUSE catalog data are maintained in two related (linked) data files, "primary.dat" and "locality.dat". The "primary" records contains specimen or taxon-lot data such as taxon identity (usually species), number of specimens, and size, whereas the "locality" records contains information on where, when, how, and by whom the specimens were collected (Figure 1). Each primary record is assigned a unique, sequential, integer-only "catalog number" and each locality record a unique "field number" with a maximum of 15 alphanumeric characters. The first accessioned collection was assigned catalog number "1." All primary records for specimens or lots from the same collection are related or linked to the same locality record by the "field number." For LFL locality records, the "field number" consists of a source-agency abbreviation (e.g., CDOW, UDWR, FWS/GJ, FWS/V), year and collection type symbol (e.g., 86L for 1986 larval fish), and unique, often sequential alphanumeric collection number (e.g., 025 or GR17) either provided by the collector or assigned by LFL. Changes or corrections in the identity of specimens in primary records are tracked in an associated taxonomic history file. Each primary record is also linked by taxon name to taxonomic dictionaries that ensure properly spelled entries and facilitate queries of the catalog at higher taxonomic levels (e.g., family and order via "CLIO," a MUSE utility). When appropriate, primary records are also linked to loan invoices so the current status of loaned material is known at all times.


```

===== LFL - MUSE VERSION 3.5.0 =====
F1=Help F4=Ditto F5=Clear Line F7=Del rec PgUp=Prv rec PgDn=Nxt rec ESC=Exit
« Primary » - Edit
Catalog #:      12345                      Field #:  FWS/GJ-86L-025
Genus:          Rhinichthys                Group #:  15
Species:        osculus
Subspecies:
Determiner/yr:  LFL/1986                  Questionable?  N
Storage:        V:1-vial                  Cataloger/yr:  DLM/1995
Fluid Count:    5      Other Count: 0      Previous #:
Preservative:   3% buffered formalin      C&S Count:    0
Preparation:
Min. Size:      9.5    Max. Size:  19.0    TL/SL:  TL
Devel. Int.     -----                  Age:    0
Type Status:
Tax. History?   N                      On Loan?  N
Inventory:      F      De-accessioned? N      Last Mod: 17-FEB-1995
Remarks:       TL LF 10mm:  L5-1, L15-4

PR FM PM MT JV AD LR, +"Y" for yolk-bearing (PRY)

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===== LFL - MUSE VERSION 3.5.0 =====
F1=Help F4=Ditto F5=Clear Line F7=Del rec PgUp=Prv rec PgDn=Nxt rec ESC=Exit
« Locality » - Edit
Acces. Date:    1995-II -16                Field #:  FWS/GJ-86L-025
Ocean/Cont:     North America
Country:        USA
State:          Colorado                   County:  Mesa
Water Body:     Gunnison River             River Km:  1.1
Locality:
Latitude:       ? ' ? ' "                Longitude: ? ' ? ' "
Salinity:       F                        Temperature:
Depth Water:    Shallow                  Depth Capt:  Shallow
Gear:           Fine mesh seine
Collectors:
Date:           24-JUL-1986              Time:  ----- Last Mod: 16-FEB-1995
Remarks:       River Mile 0.7

Use 24-hour clock

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FIGURE 1.—Larval Fish Laboratory version of MUSE computer-catalog data-entry forms; primary (taxon-lot) form on top and locality (collection) form on bottom. Active-field prompts (i.e., for "Devel. Int." and "Time" in above examples) are provided in the lower-left corner of the screen. When associated Larval Fish Laboratory or Recovery Implementation Program database files exist and are known, they are listed in the remarks field.

Notable limitations of the MUSE program are difficulty in uploading batches of data already present in other databases (e.g., dBase) and limited built-in querying capabilities. For complex queries, queries of non-indexed fields, and convenient summaries and reports, MUSE currently requires a separate database querying and reporting program either capable of accessing Btrieve data files (e.g., Xtrieve, Crystal Reports, Access) or uploading delimited ASCII output from MUSE (e.g., dBase, Paradox). Although much less convenient, LFL currently uses the latter approach and the dBase relational database program. A new Windows-based version of MUSE, which will be based on the Microsoft Access database engine, is scheduled for release in 1996 and should incorporate adequate querying and reporting capabilities. The numerous data checks and field-content specifications in MUSE make batch uploads from ASCII or other databases potentially hazardous. Accordingly, keyboard entry of catalog data has been strongly recommended in most cases. However, when uploads are necessary, MUSE Project staff will assist.

Computer and Network Hosts for LFL's MUSE Collection-Management Program

At the beginning of this project, LFL purchased a 486 computer to serve as the primary host for the MUSE collection-management program. We added essential productivity software such as a word processor, a tape backup system, and network card for connection to the Department of Fishery and Wildlife Biology LAN (local area network) and later the College of Natural Resources Network, University Backbone, and Internet. In the project's second year, we added a laser printer for printing container labels as well as related invoices, hard-copy catalogs, reports, proposals, and correspondence.

Shortly after installing, learning, implementing, and further customizing MUSE on our primary host computer, we installed a duplicate copy on another LFL computer for a second point of access. Installation of MUSE in LFL's subdirectory on the Department's LAN in the second year of this project allowed us to access the database from any LFL computer connected to the LAN. All additions or changes to the database are now made only on the network copy, but the database is frequently backed-up on tape and downloaded to the fixed drive of the primary host computer. More recent connection of LFL computers to the University network, and thereby the Internet, has facilitated electronic communication and data or file exchanges with the RIP's centralized database repository (U.S. Fish and Wildlife Service, Grand Junction), other UCRB researchers, and MUSE Project staff at Cornell University.

Collection Cataloging, Upgrades, and Reorganization

As of the end of 1995, 24,840 lots containing a total of 1,233,332 specimens and representing 5,922 collections in 61 study-year sets were cataloged, updated, and reorganized. Over 500 lots were cataloged in 1992, 3,500 in 1993, 6,800 in 1994, and the remaining 14,000 in 1995. Of the cataloged lots, 20,896 (1,071,368 specimens, 4,854 collections) were collected prior to 1994 and cataloged under this project; the remaining 3,940 lots (161,964 specimens, 1,068 collections) were collected in 1994 and 1995 and cataloged as part of collection processing (specimen identification, counts and measures). Of the 20,896 pre-1994 lots cataloged under this project, 14,466 (586,963 specimens, 3,667 collections) were collected from 1981 through 1991 and 6,430 (484,405 specimens, 1,187 collections) in 1992 and 1993. Table 1 lists, by beginning collection number, the year-

study sets of collections currently cataloged, their corresponding field (locality record) numbers, and related dBase files maintained by LFL and the RIP database repository (mostly length frequency data, sometimes additional habitat or collection data such as flowmeter readings).

Table 2 lists the taxa in cataloged collections with corresponding numbers of lots and specimens. Total counts in Table 2 include 1994 and 1995 collections that were cataloged as they were processed, whereas pre-1994 counts represent only backlog collections cataloged under this project. The cataloged collections represent eight families, 30 species, and three identified or probable hybrids. Endangered species include 2,606 Colorado squawfish *Ptychocheilus lucius*, 35 humpback chub (probably many more among 15,622 unidentified *Gila*), and 42 razorback sucker. Collections from Green River razorback sucker reproduction investigations of 1992 through 1995 include several hundred razorback sucker larvae but the collections are still in use and have not yet been cataloged.

A hard-copy (printout) of the catalog with selected primary and locality fields and a pair of corresponding dBase files including most catalog fields are maintained by LFL. Copies are not provided with this report because of their large size, but both have been sent to the RIP database repository. The dBase files, from which hard copy can be generated, are available upon request. Much information in the current collection catalog can be readily scanned or searched on-line by anyone with access to the Internet (see next section). LFL will respond to requests by researchers for needed catalog information, including data not available on-line (e.g., developmental intervals, water temperature or depth, gear).

Based on a "quick count", approximately 33,360 lots (an estimated 1.6 million specimens) collected or reared for UCRB investigations from 1976 through 1995 remain to be cataloged, upgraded, and reorganized on storage shelving. Roughly 2,000 of these uncataloged lots consist of reared series of UCRB species that were not originally considered for cataloging under this project. Another 4,940 or so backlog collections are from 1992 and 1993 Green River razorback production investigations (about 1,000 lots) and 1990 through 1995 Flaming Gorge drift-net investigations (3,940 lots). The latter includes about 1,100 lots from 1994 and 1995 for which cataloging costs were not budgeted. Other 1994 and 1995 collections have been or will be cataloged as a part of collection processing by LFL. Most of the remaining 26,420 uncataloged lots are from pre-1992 collections. Subtracting the 14,466 pre-1992 lots already cataloged from our high-end estimate of 35,000 UCRB lots held by LFL in our original proposal, we expected 20,534 pre-1992 lots to remain uncataloged. If our "quick count" is reasonably accurate, that original estimate of UCRB holdings through 1991 was about 14% (5,886 lots) too low. Together, the number of cataloged lots (24,840), and estimated number of as-yet uncataloged lots (33,360), reveal a current total LFL holdings of approximately 58,200 lots of UCRB material exclusive of unprocessed 1994 and 1995 collections (probably over 2.8 million specimens).

Cataloging, upgrading, and reorganizing 1993 and earlier collections has proceeded by project sets (e.g., 1990 Colorado and Gunnison River larval fish collections, fall 1989 Green River young-of-the year collections) generally beginning with more recent collections. Among uncataloged sets of collections, we have corresponding dBase files for only two: 1990 yearling collections (spring ISMP-Incremental Standardized Monitoring Program, 109 lots) and 1989 young-of-year collections (fall ISMP, 631 lots). Most older, uncataloged collections received lower priority since corresponding computer database files

TABLE 1.—Study-year sets of Upper Colorado River Basin collections cataloged by the Larval Fish Laboratory, Colorado State University, as of 31 December 1995.

Begin. Cat. #	Field Numbers		Descriptions of Sample Sets ^a	Associated dBase Files ^b
1	UDWR-SR89-SN01	to SN21	91Larv,StrawberryRes.,UT,Summer	(none)
36	FWS/GS-90Y-YC01	to YC76	90YOY,Colo.R,UT,Fall	90YOYCO; 90YOYCS
190	FWS/GS-90Y-0001	to 0039	90YOY,Colo.R,CO,Fall	90YOYCO; 90YOYCS
361	UDWR-GR90Y-9001	to 9081	90YOY,GreenR,UT,Fall	90YOYGR; 90YOYCS
433	FWS/GJ-91S-YC07	to YC52	91Year.,Colo.R,UT,Summer	91SPR-CO
537	UDWR-G90-NH01	to NH35B	90YOY,NH,GreenR,UT,Summer	90UTNHGR; 90UTNHCS
708	UDWR-G90-NHB01A	to NHB36B	90YOY,NH,GreenR,UT,Fall	90UTNHGR; 90UTNHCS
794	FWS/V-91Y-9105	to 9181	91YOY,GreenR,UT,Fall	91YOYGR; 91YOYGCS
852	FWS/GJ-91Y-YG65		91YOY,GreenR,UT,Fall	91YOYGR2; 91YOYGC2
855	FWS/GJ-91Y-0001	to 0040	91YOY,Colo.R,CO,Fall	91YOYCO
1056	FWS/GJ-91Y-IC01	to IC67	91YOY,Colo.R,UT,Fall	91YOYCO; 91YOYCCS
1295	UDWR-G91NS1001	to NS1120C	91YOY,,GreenR,UT,Summer	91UTNHGR; 91UTNHGCS, ...CH
1528	UDWR-G91NF1001A	to NF1115	91YOY,NH,GreenR,UT,Fall	91UTNHGR; 91UTNHGCS
1666	FWS/GJ-92S-YC02	to YC64	92Year.,Colo.R,CO,Summer	92SPR-CO, 92SPR-CS
1830	FWS/GJ-92Y-9201	to 9261	92YOY,Colo.R,UT,Fall	92YOYCO; 92YOYCS
2068	FWS/GJ-92Y-0001	to 0041	92YOY,Colo.R,CO,Fall	92YOYCO
2319	UDWR-G91NS1021B		91YOY,NH,GreenR,UT,Summer	91UTNHGR
2321	FWS/GJ-92Y-GU01	to GU42	92YOY,Gunn.R,CO,Fall	92YOYGU
2534	UDWR-GR92Y-9201	to 9281	92YOY,GreenR,UT,Fall	92YOYGR; 92YOYGCS
2573	FWS/GJ-93S-YC01	to YC18	93Year.,Colo.R,UT,Summer	93SPR-CO; 93SPRCES
2638	FWS/GJ-93S-FW01	to FW28	93Year.,Colo.R,UT,Summer	93SPR-CO
2725	UDWR-G91NS1004B		91YOY,NH,GreenR,UT,Summer	91UTNHGR; 91UTNRRZ
2726	FWS/GJ-91L-001	to 256	91Larv.,Colo.&Gunn.R, CO&UT,Sum.	91LARVAE; 91LAR-ES
4033	FWS/GJ-90L-0001	to 0297	90Larv.,Colo.&Gunn.R, CO&UT,Sum.	90LARVAE; 90LAR-ES
5569	FWS-92ANHS2001A	to S2030C	92Larv.Asp.NH,Colo.R,CO,Summer	92ANHCO
5877	FWS-92ANHF2001	to F2019	92YOY,Asp.NH,Colo.R,CO,Fall	92ANHCO
6053	FWS/GJ-93Y-YC01	to YC76	93YOY,Colo.R,UT,Fall	93YOYCO; 93YOYCCH, ...CS
6429	FWS/GJ-93Y-GR17	to GRX1	93YOY,GunnR,CO,Fall	93YOYLGR; 93YLGRCS
6456	FWS/GJ-93Y-0001	to 0038	93YOY,Colo.R,Fall	93YOYCO2; 93YCO2CH
6672	FWS/GJ-93Y-GU01	to GU60	93YOY,Gunn.R.,CO,Fall	93YOYGU
7138	FWS/GJ-93L-GU01	to GU35	93Larv.,Gunn.R.,CO,Summer	93LARGU
7362	UDWR-G93NS301A	to NS364C	93YOY,NH,GreenR.,UT,Summer	93UTNHGR; 93UTNHES
7707	UDWR-G93NF301B	to NF340C	93YOY,NH,GreenR.,UT,Fall	93UTNHGR; 93UTNHES
7949	FWS/GJ-94S-01	to 70	94Year.,Colo.R,UT,Summer	94SPR-CO; 94SPRCES
8179	FWS/GJ-89L-0002	to 0230	89Larv.,Colo.&Gunn.R.,CO&UT,Sum.	89LARVAE
9243	CDOW-91D-CO1A	to CO3B	91Larv,DN,Colo.R.,CO,Summer	(none)
9261	FWS/GJ-92L-GU01	to GU35	92Larv.,Gunn.R,CO,Summer	92LARGU
9458	FWS/GJ-92L-001	to 256	92Larv.,Colo.&Gunn.R.,CO&UT,Sum.	92LARVAE; 92LAR-ES
10866	FWS/GJ-88L-001	to 244	88Larv.,Colo.&Gunn.R.,CO&UT,Sum.	(none)

(table continued)

TABLE 1.—Continued

Begin. Cat. #	Field Numbers		Descriptions of Sample Sets*	Associated dBase Files**
11728	FWS/GJ-87L-001	to 108	87Larv., Colo. & Gunn. R., CO, Summer	(none)
12232	FWS/GJ-86L-001	to 122	86Larv., Colo. & Gunn. R., CO, Summer	(none)
12817	FWS/GJ-85L-001	to 246	85Larv., Colo. & Gunn. R., CO & UT, Sum.	(none)
13822	NPS-94LS-103	to 418	94, LittleSnakeR., CO, Spring-Fall	NPS-LS94
13942	FWS/GJ-84L-001	to 206	84Larv., Colo. & GreenR., CO & UT, Sum.	84GJLAR (GJLAR84)
14654	NPS-94LS-406	and 420	94, LittleSnakeR., CO, Spring-Fall	NPS-LS94
14657	FWS/GJ-83L-001	to 254	83Larv., Colo. & Gunn. R., CO & UT, Sum.	83GJLAR (GJLAR83)
15375	FWS/GJ-82L-001	to 204	82Larv., Colo. & Gunn. R., CO & UT, Sum.	82GJLAR (GJLAR82)
16226	FWS/GJ-81L-GS01	to TF07	81Larv., Colo. R., CO & UT, Summer	(none)
16413	FWS/V-81L-GR001	to 334	81Larv., GreenR., CO & UT, Summer	(none)
16942	FWS/V-81L-WH001	to WH114	81Larv., WhiteR., CO & UT, Summer	(none)
17248	CDOW-81LYABH002	to BH089	81Larv., YampaR., CO, Summer	(none)
17453	CDOW-81LYAEW001	to EW182	81Larv., YampaR., CO, Summer	(none)
17928	CDOW-81LYAJH001	to XXXXX	81Larv., YampaR., CO, Summer	(none)
17939	CDOW-81LYABH01A	to BH84A	81Larv., YampaR., CO, Summer	(none)
18081	FWS/V-85L-YA001	to GR139	85Larv., Yampa & GreenR., CO & UT, Sum.	(none)
18668	FWS/V-82L-GR025	to YA229	82Larv., Yampa & GreenR., CO & UT, Sum.	(none)
19110	FWS/V-82L-YA002	to YA135	82Larv., YampaR., CO, Summer	(none)
19258	FWS/V-84L-GRA01	to GRC94	84Larv., GreenR., CO & UT, Summer	(none)
19765	FWS/V-83L-GR01	to YA24	83Larv., Yampa & GreenR., CO & UT, Sum.	(none)
19865	FWS/GJ-93L-001	to 255	93Larv., Colo. & Gunn. R., CO & UT, Sum.	93LARVAE; 93LAR-ES
21252	FWS/GJ-94Y-0001	to YG92	94YOY., Colo. & GreenR., CO & UT, Fall	94YOY; 94YOY-ES
21802	FWS/GJ-93L-185		93Larv., Colo. & Gunn. R., CO & UT, Sum.	93LARVAE
21803	CDOW-94DR-A001	to W002	94Larv., DN, Colo. & Gunn. R. CO, Spr-Sum	94DOWDRF; 94DOWDRC; ...CS
23644	FWS/GJ-94L-001	to 256	94Larv., Colo. & Gunn. R., CO & UT, Sum.	94LARVAE, 94LAR-ES
24741	FWS/GJ-95S-LC01	to UC25	95Year., Colo. R., UT, Spring	95SPR-CO; 95SPRCES
24853	(next set)			

^a Life stages targeted: Larv. = Larvae, YOY = young-of-year, Year. = yearlings; NH = Nursery Habitat; DN = drift net.

^b File names with the "DBF" suffix; these are usually files with additional length frequency or individual length data (species of special concern), but sometimes files with additional locality or sampling data such as flow meter readings.

are not available on LFL computers. For those sets of collections that also lack documentation in RIP database repository files, additional time will be required to track and obtain needed collection data not on container labels. For many of these earlier sets of collections, copies of original field sheets, sample processing data forms, and associated reports will be needed. Once in the catalog, selected data can be downloaded to dBase files and submitted to the database repository.

As taxon-specific lots of specimens are cataloged, they are assigned a sequential catalog number, designated as voucher, study, or reference material (denoted by a V, S, or R, respectively, in the storage field of the primary record and the lower left corner of the

TABLE 2.—Taxa in cataloged Upper Colorado River Basin collections with corresponding numbers of lots and specimens, as of 31 December 1995. Total counts include 1994 and 1995 collections cataloged as they were processed, whereas pre-1994 collections (1981 through 1993) were cataloged under this project.

Taxon Class/Order/Family/Genus species	Number of Lots		Number of Specimens	
	Total	Pre-1994	Total	Pre-1994
Actinopterygii	24,840	20,896	1,233,332	1,071,368
Cypriniformes	23,421	19,731	1,223,095	1,063,374
Cyprinidae	18,404	15,300	1,126,413	971,221
<i>Cyprinella lutrensis</i>	4,074	3,572	584,489	533,522
<i>Cyprinus carpio</i>	378	216	1,486	454
<i>Gila atraria</i>	17	17	82	82
<i>Gila cypha</i>	25	25	35	35
<i>Gila robusta</i>	994	982	7,439	7,412
<i>Gila</i> sp.	1,362	902	15,622	14,110
<i>Hybognathus hankinsoni</i>	1	1	1	1
<i>Notropis stramineus</i>	3,144	2,653	167,137	122,019
<i>Pimephales promelas</i>	3,638	2,989	279,289	232,653
<i>Ptychocheilus lucius</i>	620	554	2,606	2,495
<i>Rhinichthys osculus</i>	3,043	2,502	58,466	50,085
<i>Richardsonius balteatus</i>	129	111	2,789	2,005
<i>Richardsonius balteatus</i> x <i>Rhinichthys osculus</i>	1	1	1	1
<i>Semotilus atromaculatus</i>	6	6	16	16
sp. (unident. Cyprinidae)	972	769	6,955	6,331
Catostomidae	5,017	4,431	96,682	92,153
<i>Catostomus ardens</i>	4	4	35	35
<i>Catostomus catostomus</i>	22	22	111	111
<i>Catostomus commersoni</i>	422	384	4,811	4,526
<i>Catostomus discobolus</i>	3,268	2,899	77,905	75,017
<i>Catostomus latipinnis</i>	1,123	957	13,046	11,734
<i>Catostomus latipinnis</i> x <i>commersoni</i>	1	1	1	1
<i>Catostomus latipinnis</i> x <i>discobolus</i>	4	4	4	4
<i>Catostomus platyrhynchus</i>	3	3	4	4
<i>Xyrauchen texanus</i>	18	18	42	42
sp.(unident. Catostomidae)	152	139	723	6790
Siluriformes	139	129	579	550
Ictaluridae	139	129	579	550
<i>Ameiurus melas</i>	19	17	82	66
<i>Ictalurus punctatus</i>	120	112	497	484

(table continued)

TABLE 2.—Continued.

Taxon Class/Order/Family/Genus species	Number of Lots		Number of Specimens	
	Total	Pre-1994	Total	Pre-1994
Salmoniformes	1	1	1	1
Salmonidae	1	1	1	1
<i>Prosopium williamsoni</i>	1	1	1	1
Atheriniformes	764	656	7,900	6,154
Poeciliidae	524	452	7,357	5,688
<i>Gambusia affinis</i>	524	452	7,357	5,688
Cyprinodontidae	240	204	543	466
<i>Fundulus zebrinus</i>	240	204	543	466
Scorpaeniformes	21	18	117	111
Cottidae	21	18	117	111
<i>Cottus bairdi</i>	21	18	117	111
Perciformes	442	309	1,640	1,178
Centrarchidae	442	309	1,640	1,178
<i>Lepomis cyanellus</i>	404	275	1,420	964
<i>Lepomis macrochirus</i>	5	4	8	6
<i>Micropterus dolomieu</i>	1	1	1	1
<i>Micropterus salmoides</i>	29	26	33	29
<i>Pomoxis nigromaculatus</i>	3	3	4	4
Unidentified sp.	52	52	174	174

label), and organized on collection shelving accordingly. Voucher specimens are those collected and preserved from a specific location at a specific time and as such represent a historical natural occurrence or sample of natural history. Most UCRB collections held by LFL are voucher collections. Such collections are stored on shelving according to container size (usually vials in trays on upper shelves and a mix of larger containers on lower shelves) and ordered serially within either of those two groupings by catalog number. When possible, all lots from the same collection and all collections from the same collecting event or investigation are cataloged and stored together in sequence (except for storage separation according to container size). Study collections consist of specimens that lack associated collection location or date information or were artificially reared, preserved during or at the conclusion of laboratory or field experiments, or selectively and permanently removed from voucher collections for morphological examination, descriptive study, or other educational or research purposes. Reference collections are special subsets of these that are conveniently organized for routine comparison with collected material to aid taxonomic identification. Study and reference specimens are stored separately from voucher material and are organized according to more standard museum practice, first phylogenetically (by species), then by catalog number.

To facilitate organization of cataloged collections on LFL shelving and minimize evaporative losses, we have standardized containers to 20-ml glass scintillation vials with Polyseal™ caps, and 2, 8, and 16-oz straight-sided jars (83, 134, and 147-mm tall,

respectively) with special teflon-lined lids. Most older material in containers larger than vials has been or will be transferred to these standard-size containers. To maximize use of very limited space, vials are stored in 100-vial trays on shelves close to but separate from shelves used for larger containers. Currently, the larger containers are ordered loosely on shelves without retention bars; in the future we hope to first organize them in sturdy trays or bins. Such trays or bins should prevent the jars from accidentally being knocked off shelves and facilitate access to containers stored towards the back of the shelf. Containers larger than 16 oz are avoided, but when required, they are stored on still another set of shelves to accommodate their greater height. In some cases it has been necessary to bottle individual lots in more than one container (e.g, two vials instead of a 2-oz jar). The number and size of containers for each lot are recorded with collection type (V, S, or R) in the storage field of the primary record and in the lower left corner of the label; information in this field is used to determine on which shelves lots are stored. Container labels also have been standardized (Figure 2). They are printed on 28# Byron-Weston Resistall paper with a laser printer and cut to about 33 x 51 mm to accommodate our smallest containers (20-ml vials).

LFL 2725	Catostomidae: 14	LFL 13153	Cyprinidae: 15	LFL 22334	Cyprinidae: 15
<i>Xyrauchen texanus</i>		<i>Gila cypha</i> ?		<i>Ptychocheilus lucius</i>	
N = 2, 36.6-39.3 mmTL	Dev Int: JV	N = 1, 16.4-16.4 mmTL		N = 7, 9.0-10.0 mmTL	Dev Int: LR
100% ethanol	Id: Kevin Bestgen/91	3% buffered formalin	Id: LFL/1985	100% ethanol	Id: LFL/1995
UDWR-G91NS1004B	30-JUL-1991	FWS/GJ-85L-079	26-JUL-1985	CDOW-94DR-L035	12-JUL-1994
North America, USA, Utah, Grand Co.	River Km: 89.5	North America, USA, Utah, Grand Co.	River Km: 181.4	North America, USA, Colorado, Mesa Co.	River Km: 247.5
Green River		Colorado River		Colorado River	
		Shoreline		LOMA	
Gear: seine		Gear: Fine mesh seine		Gear: Larval fish drift net	Col: CL
V:2-vials	Larval Fish Laboratory, Colo. St. Univ.	V:1-vial	Larval Fish Laboratory, Colo. St. Univ.	V:1-vial	Larval Fish Laboratory, Colo. St. Univ.

FIGURE 2.—Larval Fish Laboratory collection labels.

The settled level of specimens in storage containers is generally limited to no more than 75% of container height. Because of interstitial space among specimens, this ensures a volumetric ratio of at least twice as much preservative as specimens in each container. Preservative is denoted in the primary record and on the label for each lot. Most collections maintained by LFL are stored in 3% phosphate-buffered formalin, but many, especially from more recent investigations, are preserved in 95-100% ethanol for potential otolith analysis of age or confirmation of identity by PCR-DNA techniques. Most specimens that have been cleared and stained for skeletal examination are maintained in 100% glycerol. Collection containers are checked once a year for evaporative losses of preservative.

As our holdings of UCRB collections have grown, we have filled all existing shelving allocated for their storage and care. All cataloged and most uncataloged UCRB collections are currently stored on specially constructed rows of wooden shelving that are aligned perpendicular to the east wall of our laboratory (Wagar Building, room 33). The shelving was custom-designed and built by LFL for this purpose in spring 1987 with funds provided by the Colorado Division of Wildlife on behalf of the RIP. The shelving units are

stable but should further secured by fastening to adjacent walls and braces between rows. Also, the shelves themselves need reinforcement to prevent bowing. We have tentative plans to allocate space either in an adjacent room (33A) or along a portion of the south wall of the lab to accommodate excess backlog and future UCRB collections. This expansion of collection holding facilities will require some remodeling and additional rows of shelving, preferably metal shelves.

On-line Searches of the Larval Fish Laboratory Collection Catalog

The LFL collection catalog is now available for on-line Internet searches via the (World-Wide) Web or Gopher. Copies of our catalog data files reside on a MUSEServer maintained by the MUSE Project at Cornell University. Updated primary and locality files will be periodically forwarded to that Server. Pending availability of an older, Windows-capable computer that can serve as LFL's own dedicated MUSEServer, on-line access will eventually be in real time and thereby include the very latest entries and corrections. For preserved collections maintained by LFL, the on-line catalog will complement the numerous dBase files of data maintained by the RIP database repository and provide quick and easy access from any internet-connected personal computer. Not all information in the database is provided via on-line searches—only catalog and field numbers, species, number and size of specimens, type status, country, state, county, locality, collection date, collectors, and remarks.

To access the LFL and other fish-collection catalogs on the Web, use an appropriate Web browser (e.g., Mosaic or Netscape) and open to the Biodiversity and Biological Collections Server at <http://muse.bio.cornell.edu>. From there select "Ichthyology", then "Query On-line Fish Database" which takes you to "Fish Searches" (or open directly to "Fish Searches" at <http://muse.bio.cornell.edu/taxonomy/fishsearch.html>). From there your options are: (1) query by example using taxonomy and geography, (2) query by catalog number or field number, (3) query by species with map-based output (USA only; Figure 3), or (4) query using hierarchical classification (beginning at class or subclass level and working down to species and individual records). If your browser can't handle forms or you prefer a WAIS-type Gopher search (searches on any word in available fields), options for Gopher searches are also available on the same Web page. If you don't have a Web browser, connect with the Biodiversity and Biological Collections Gopher site (muse.bio.cornell.edu) and select "FishGopher." As of this report, only LFL, Cornell University, Harvard University Museum of Comparative Zoology, and University of Michigan Museum of Zoology fish collections are available for MUSEServer (Web) searches. However, WAIS-type Gopher searches of individual or multiple catalogs also cover fish collections of the Academy of Natural Sciences (Philadelphia), Bishop Museum (Hawaii), Field Museum (Chicago), University of Alabama, University of Kansas Natural History Museum, Swedish Museum of Natural History, and Museu de Ciencias e Tecnologia da PUCRS (MCP, Brazil).

Collection Permanency, Association with Other Collections or Museums

As LFL holdings are properly cataloged and maintained, the status of these holdings as a long-term collection is vastly improving. Association of our collection with a more permanent collection or museum, especially one willing to adopt the specimens if



FIGURE 3.—Map displayed after an on-line (World-Wide Web) MUSEServer search for *Ptychocheilus lucius* records in the University of Michigan Museum of Zoology fish collection catalog. Clicking on any of the county-based distributional dots results in a display of selected data from catalog records associated with that county.

necessary, is much more likely if the collection is cataloged and well maintained. To ensure collection permanency, we originally had hoped to establish a formal link with an appropriate, preferably local or regional, museum or permanent collection such as the U.S. Fish and Wildlife Service Field Station Collections (now NBS Western Biological Surveys Collections), which is itself associated with the U.S. National Museum (Smithsonian Institution). Such an arrangement would be particularly valuable should LFL be unable to continue maintaining UCRB collections, especially after the RIP completes its mission. However, a direct link with the Field Station Collections, which is now located in Albuquerque in association with MSB, does not appear to be a viable option at this time. Possibilities for formal links with other permanent collections or museums, including MSB, have yet to be explored.

As an alternative, we have joined the curators and collection managers of other natural-history collections in Colorado in establishing the ad hoc Colorado Alliance of Biodiversity Collections (CABC). One of the primary functions of that organization will be to help ensure the permanency and proper care of all Colorado natural-history collections, but the means for doing such have not yet been developed, and the future of the organization is itself uncertain.

CABC also proposes to eventually include catalog data from all Colorado collections in a core database for easy, consolidated access by researchers and resource managers. If CABC is successful in achieving this goal, coverage may eventually include Colorado material maintained by out-of-state museums and collections (e.g., MSB), or CABC might expand or merge with similar efforts in other states to become a more regional organization. LFL might also join an independent effort to establish a southwest-regional network of fish collections including MSB and collections at the University of Texas, Texas A & M University, Oklahoma State University, University of Oklahoma, Arizona State University, and institutions in northern Mexico. Through either or both of these organizations, at least

the catalogs of the LFL Collection, NBS Western Biological Surveys Collections, and MSB might eventually be linked, allowing simultaneous access to data on most cataloged UCRB specimens.

Finally, LFL and the curators or managers of other natural-history collections on the Colorado State University campus are proposing formal University recognition and budgetary support of campus collections, perhaps under the umbrella of a "University Museum of Natural History Collections." Although hopeful, none of these efforts have yet made any real progress towards ensuring permanency of the LFL Collection. LFL will continue to pursue these and other possibilities.

Larval Fish Laboratory Collection Manual

Appendix II is a draft manual of policies and procedures for the Larval Fish Laboratory Collection including accessions, cataloging, maintenance, and use. Where practical, policies follow guidelines recommended by the Association of Systematics Collections (Hoagland 1994). Curatorial procedures have been established in part through experience, consultation with curators or managers of other collections, and guidelines and suggestions in various publications of the Collections Committee of the American Society of Ichthyologists and Herpetologists, including their Curation Newsletter. As of this report, the manual is still undergoing in-house review. Extensive outside review is planned.

Cataloging Time and Costs

Table 3 documents the time required by our collection assistant to catalog and handle five sets of backlog UCRB collections. Average times varied considerably depending on the specific set of collections considered (e.g., 3.6 to 8.5 minutes per lot). However, if the combined averages for these five sets of collections are considered representative, the average UCRB collection consists of about 5 species-lots and requires about 28 minutes to catalog and handle, about 6 minutes per lot. Costs for cataloging backlog collections depend on the rate billed for such services. Based on mean times in Table 3 and an updated LFL hourly rate for laboratory technician services (a rate structured to cover salary and wages, benefits, supervision, and laboratory and university overhead), average cataloging and handling cost would be \$1.95 per lot or \$9.13 per collection (exclusive of materials costs). Considering all collections cataloged as of this report, the overall average number of lots per collection is actually 4.2 rather than the 4.7 figure in Table 3; average cost per collection based on this overall figure (and 6 minutes per lot) would be \$8.19.

Using the above figures, it will take about 3,336 man-hours (about 2 full-time years for one person) and cost about \$65,052 for labor to catalog the remaining backlog of 33,360 lots of preserved UCRB specimens. Materials such as label paper, fluids, trays and museum jars will cost at least an additional \$2,000.

Costs are somewhat less for cataloging new collections as they are processed. Collections and data are at hand and do not need to be "found", containers and preservatives do not need to be upgraded, and collection handling is reduced. For 1994 through 1996 collections we increased per collection charges for processing by about 5% to cover the additional costs for cataloging, but this is probably insufficient and will need to be reconsidered in future contracts.

TABLE 3.—Time to catalog and handle five sets of collections (create locality and primary records, find subject lots, resolve discrepancies, upgrade lot containers and preservative if necessary, print, cut, and insert catalog labels, and reorganize lots on storage shelving).

Set (Yr.)	No. of Col.	No. of Lots	Lots/Col.	Total Hours	Minutes/Col	Minutes/Lot
1 (1987)	108	504	4.7	71.0	39.4	8.5
2 (1988)	243	862	3.5	86.3	21.3	6.0
3 (1989)	230	1064	4.6	87.4	22.8	4.9
4 (1990)	297	1536	5.2	92.3	18.6	3.6
5 (1992)	289	1605	5.6	184.0	38.2	6.9
Mean	233	1114	4.7	104.2	28.1	6.0

Conclusions

This project has successfully improved the maintenance and accessibility of nearly half the 58,200 preserved lots of UCRB larval and small fish collections now held by LFL on behalf of RIP participants. These collections, consisting of an estimated 2.8 million specimens, serve as voucher for nearly two decades of monitoring and research in the basin and as a valuable historical resource for future investigations.

We have adopted the NSF-supported MUSE program for collection cataloging and management. MUSE was originally designed for ichthyological collections and is now licensed for use by over 80 museum or institutional collections world-wide. Much of the data in our collection catalog (database) is now available on-line from any computer connected to the Internet. A policies and procedures manual for the management, maintenance, and use of the LFL Collection has been drafted and is under review.

As of the end of 1995, nearly 43% (24,840 lots, 1.2 million specimens) of LFL's UCRB holdings have been cataloged, upgraded as necessary (containers and preservative), and reorganized on collection shelving. About 84% (20,896 lots) of those lots were cataloged under this project and the remainder, all 1994 and 1995 collections, as part of collection processing for RIP participants. Approximately 33,360 lots collected since 1976 remain to be cataloged, upgraded, and reorganized. Time and labor costs for finishing the task begun by this project are estimated at 2 full man-years and \$65,052; materials costs at \$2,000. Additional shelving, for which LFL will allocate space, will also be required to accommodate yet-to-be processed 1994, 1995, and future collections.

We have had only limited success in our efforts to secure the permanency of these UCRB collections beyond LFL, but completion of the cataloging task should facilitate future efforts in this regard. The proposed formal link with the repository for preserved collections of larger fishes from the UCRB, currently the NBS Western Biological Surveys Collections housed by MSB in Albuquerque, does not appear to be practical or beneficial at this time. However, we have established membership in the fledgling Colorado Alliance of Biodiversity Collections, one purpose of which is to help ensure adequate care and a home for orphaned or troubled collections in Colorado. We have also initiated a proposal for formal recognition and support of this and other on-campus natural history collections within Colorado State University.

Recommendations

Preserved collections from the UCRB serve as voucher for many RIP investigations and as a long-term source of additional biological and historical information. In recognition of their importance to RIP, we (the principal investigators for this project) recommend incorporation of a new General Recovery Program Support task in RIPRAP—to "provide for the long-term care, cataloging, and accessibility of preserved collections as voucher for Recovery Implementation Program research and as a resource for additional taxonomic, biological, and natural history information."

A substantial number of UCRB backlog collections (57% of current holdings) remains uncataloged, minimally labeled, sometimes in non-standard containers, and variously placed on existing shelving, boxed, or stacked on floors and counters. A proposal will be submitted to complete work on backlog collections. We recommend continued support of this effort.

Beginning with our contracts for processing 1994 collections (FY 95), we included a 5% increase in estimated cost per sample to cover collection cataloging, catalog labeling, and initial maintenance. That figure will be revised in future contracts to reflect more precise estimates of the time and effort required for those tasks. We recommend that all future contracts for sample processing and projects requiring preserved collections include adequate funds for cataloging and initial maintenance tasks.

We now hold more UCRB collections than can be accommodated on existing shelving. We have tentatively identified space near the current storage area for expanded collection storage (a portion of adjacent room 33A or space along the lab's south wall), but additional shelving or cabinets will be needed. Provisions for new shelving and related facility modifications (if necessary) will be included in the above referenced proposal for completing work on backlog collections. Some improvements to existing shelving are also needed. We recommend RIP support for expansion of collection storage capacity and improvements to existing shelving.

Beyond initial cataloging and handling, collection maintenance and management is an ongoing responsibility. Collections require periodic (at least annual) checks of fluid levels, condition of containers, and proper organization on storage shelves. Collection access and use, including loans and transfers, must be facilitated, approved, monitored, and documented on behalf of the RIP. Once the proposed project to complete work on backlog collections is finished, we recommend annual recovery program funding of ongoing curatorial activities by LFL, perhaps as part of or in association with the ongoing Database Management Program.

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- Humphries, J. 1994. MUSE tutorial and reference manual, 7th edition. The MUSE Project, Cornell University, Ithaca, New York.
- Snyder, D. E. Draft. Larval Fish Laboratory Collection policies and procedures manual. Larval Fish Laboratory, Colorado State University, Fort Collins, Colorado.

Appendix I

List by Discipline of Collections Licensed to Use the MUSE Program

List by discipline of collections licensed to use the MUSE program as of fall 1995. MUSE was initially designed for ichthyological collections but is being increasingly adapted for other disciplines. Collections in bold print are those of Colorado and neighboring states.

Discipline	Collection Site Name
Botany (1 collection):	Bogor Herbarium, Indonesia (administered through Harvard)
Vertebrates (1 collection):	SUNY College of Environmental Science and Forestry, NY
Mammalogy (2 collections):	Cornell University Museum of Comparative Zoology, Harvard University
Ornithology (3 collections):	Cornell University National University of Singapore University of Michigan, Museum of Zoology
Herpetology (14 collections):	Academy of Natural Sciences, Philadelphia American Museum of Natural History, New York, NY Cornell University Escuela Politecnica Nacional, Ecuador Museo Nacional de Historia Natural de Paraguay Museu Nacional Do Rio De Janeiro, Brazil Museum of Comparative Zoology, Harvard University Pontificia Universidad Catolica del Ecuador San Diego Natural History Museum Swedish Museum of Natural History Texas A&M University - Texas Cooperative Wildlife Collection Texas Memorial Museum - Texas Natural History Collection Universidad de los Andes, Venezuela University of Texas at Arlington
Ichthyology (47 collections):	Academy of Natural Sciences, Philadelphia Arkansas Tech University ^a Atlantic Reference Centre of the Huntsman Marine Science Centre, New Brunswick, Canada Bishop Museum, Hawaii California Academy of Sciences Centro de Investigaciones de Quintana Roo, Mexico Collection Maurice Kottelat (Cornol, Switzerland) Cornell University Escuela Politecnica Nacional, Ecuador Field Museum of Natural History, Chicago Florida Museum of Natural History Fundacao Universidade de Rio Grande, Brazil

(table continued)

Discipline	Collection Site Name
	Grice Marine Biological Laboratory, Charleston, SC ^a
	Gulf Coast Research Laboratory Museum ^a
	Institute of National Museum of Marine Science & Technology, Nankang, Taiwan
	Larval Fish Laboratory - Colorado State University
	Museo De Biología, Universidad Central de Venezuela
	Museo de Ciencias da Pontifica Universidade Católica do Rio Grande do Sul, Brazil
	Museo de La Plata, Argentina
	Museu de Zoologie, Sao Paulo, Brazil
	Museo Nacional de Historia Natural de Paraguay
	Museu Nacional Do Rio De Janeiro, Brazil
	Museum of Comparative Zoology, Harvard University
	Museum of Southwestern Biology, University of New Mexico, Albuquerque^b
	Museum of Natural History, University of Kansas
	National Museums of Kenya
	Neodat Master Database version of MUSE
	New York State Museum
	Ohio State University Museum of Zoology
	Oklahoma State University
	Oregon State University ^a
	Penn State University
	South African Museum, Cape Town
	Swedish Museum of Natural History
	Texas A&M University - Texas Cooperative Wildlife Collection
	Texas Memorial Museum - Texas Natural History Collection
	Tulane Museum of Natural History
	UNELLEZ - Museo de Ciencias Naturales de Guanare, Venezuela
	Universidad Autonoma de Santo Domingo, Dominican Republic
	Universidad de Costa Rica
	Universidad Nacional Autonoma de Mexico
	Universidade Federal do Rio Grande do Sul, Brazil
	University of Alabama
	University of Arizona^a
	University of Malaya
	University of Michigan, Museum of Zoology
	Zoologische Staatssammlung, Munich, Germany
Invertebrates (1 collection):	Atlantic Reference Centre of the Huntsman Marine Science Centre, New Brunswick, Canada
Invertebrate Paleontology (1 collection):	Museum of Comparative Zoology, Harvard University
Malacology (2 collections):	Museum of Comparative Zoology, Harvard University
	Santa Barbara Museum of Natural History, California
Acarology (1 collection):	Canadian National Collection, Ontario, Canada
Astacidae (Crayfish; 2 collections):	New York State Museum
	Ohio State University

^a Collection has not yet begun data entry.

^b Collection has set aside plans to use MUSE in favor of its own in-house system based on Paradox.

Appendix II

Larval Fish Laboratory Collection Policies and Procedures Manual

Draft, 24 April 1996

(the following document is independently paginated)

LARVAL FISH LABORATORY COLLECTION

POLICIES AND PROCEDURES MANUAL

*** Draft ***

24 April 1996

Prepared by

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Laboratory for the Study and Identification of Fishes in North American Fresh Waters

Research
Early Life Stages/Adults
Native Fish Biology/Ecology
Aquatic Toxicology/Behavior

Education
Extension/Consultation
Study Design/Analysis
Shortcourses/Guest Lectures

Service
Identification/Verification
Sample Processing/Depository
Descriptions/Keys/Illustrations

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Early drafts were carefully reviewed and considered by LFL staff including Robert Muth, Kevin Bestgen, Daniel Beyers, and John Hawkins, and collection assistant Diane Miller. Before this document or a subsequent revision is considered final, it will be further reviewed by appropriate university officials, curators of other collections, and representatives of agencies or programs that have contributed substantially to the holdings of the LFL Collection.

Mission of Larval Fish Laboratory

The Larval Fish Laboratory (LFL) at Colorado State University was established in fall 1978 within the College of Natural Resources and Department of Fishery and Wildlife Biology as a largely self-supporting entity relying on contracts, service fees, and grants. Its mission is to advance knowledge of the taxonomy, life history, and ecology of fishes in North America's freshwaters through research, service, and education, with emphasis on the early life stages.

Purpose of the LFL Collection

The Larval Fish Laboratory Collection is a repository for the preserved eggs, larvae, small juveniles, and small adults of North American freshwater and anadromous fishes. Its purpose is to maintain and provide controlled public access to those specimens and associated collection and specimen data as a long-term taxonomic, biological, and natural-history resource. The collection is especially intended to further LFL's own functions of research, service, and education and help safeguard potentially valuable voucher, study, or reference specimens that might otherwise be discarded and lost to science.

Status of the LFL Collection, January 1996

The LFL Collection include over 200 species of fish from throughout the United States and portions of Canada with some material dating back to the early 1950s. However, the vast majority of LFL holdings, over 58,000 lots and an estimated 2.8 million specimens, have been deposited by various agencies associated with the effort to monitor and recover rare and endangered fishes of the Upper Colorado River Basin (UCRB).

Most LFL holdings, including all specimens from outside the UCRB, remain uncataloged backlog. With support of the Recovery Implementation Program for Endangered Fishes of the Upper Colorado River Basin (RIP), a computer collection catalog and management system was established in 1992 and nearly half the UCRB collections (24,840 lots, 1.2 million specimens) have since been cataloged, upgraded as necessary with standardized containers and preservative, and reorganized for ready access on storage shelving. Most new UCRB material processed by LFL (e.g., identified, counted, and measured) is cataloged as part of that process.

Colorado State University, through the College of Natural Resources and Department of Fishery and Wildlife Biology, supports LFL and its collection in part by allocation and maintenance of space and facilities on main campus in the west-wing basement of the Wagar Building (room 33 complex). However, the university does not provide the materials and salary needed to maintain, catalog, management, or provide access to LFL's rapidly growing collection. Until such long-term, baseline support can be secured, the LFL Collection will continue to be at least minimally maintained and managed as long as possible through overhead on LFL research and service activities and the voluntary contributions of time and effort by LFL staff. RIP funding for establishment of a computerized collection cataloging and management system, establishment and documentation of standard collection policies and procedures, and the upgrading and cataloging of nearly half of the UCRB holdings has been a major contribution towards

improved care, management, and accessibility for that portion of the collection. Aside from long-term materials and salary support for on-going collection maintenance and management, priorities for solicitation of future support include: (1) expansion of collection storage capacity, (2) shelf trays for lots in 2, 8, and 16-oz jars, (3) upgrades to and cataloging of remaining UCRB backlog lots, (4) upgrades to and cataloging of all other (non-UCRB) backlog specimens, (5) reinforcement of wooden shelving, and (6) continued efforts to ensure the permanency of the collection. Appendix I is a more detailed draft strategic plan for the LFL Collection.

LFL Collection Policies and Procedures

Within the financial, facility, and practical limitations of LFL, collection management and policies follow guidelines set forth in the Association of the Systematic Collections *Guidelines for Institutional Policies and Planning in Natural History Collections* (Hoagland 1994). Curatorial procedures were established in part through experience, consultation with curators and managers of other collections, and guidelines and suggestions in various publications of the Collections Committee of the American Society of Ichthyologists and Herpetologists, including *Curation Newsletter*. These policies and procedures become formally effective at such time as this manual is considered final by LFL (as indicated by removal of the word "draft" from the title page). Most have long been standard, if undocumented, LFL practice, some were more recently established (e.g., collection cataloging in 1991), and a some (e.g., formal accessions procedures) remained to be implemented as this document was prepared and reviewed.

Administration

Management and policy for the LFL Collection are the collective responsibility of LFL's senior staff but are subject to pertinent federal, state, and university regulations and policies. One member of LFL's senior staff is designated as the LFL Collection Curator and is responsible for overseeing all curatorial activities in accord with the following policies and procedures. The curator may be assisted in these responsibilities by a collection manager or assistant, other principal staff, and laboratory technicians or student volunteers. Decisions by the curator may be appealed to the LFL Director for joint reconsideration by LFL's senior staff.

Acquisitions and Accessions

Specimens for the LFL Collection are acquired through in-house research and culture, deposition by public and private agencies and researchers (often from collections processed or taxonomically verified by LFL), and exchanges with other researchers, organizations, and museums maintaining similar collections. Except for educational and reference purposes, LFL generally restricts acquisitions to early life stages (eggs, larvae, and young-of-the-year and yearling juveniles) and small adults of fishes from North America's freshwaters and estuaries. Within that scope and available physical and financial resources, LFL considers most offers for deposition, donation, or exchange of specimens and particularly encourages offers of taxa and life stages not well represented in LFL holdings. However, contributions of large sets of

voucher material outside of Colorado and the Upper Colorado River Basin should first be offered to more regionally appropriate and more permanent repositories. LFL defers deposition of type specimens to permanent museum collections, but does maintain specimens used for description or illustration of early life stages. LFL does not knowingly accept illegally or unethically collected, obtained, or transferred specimens. LFL does not buy or sell specimens.

Contributions of Specimens—Offers must be approved by the curator before specimens are deposited with the LFL Collection. When possible, the donor is asked to also contribute sufficient funds to cover initial curatorial costs including cataloging, standardized collection containers, and organization on collection shelving. However, this is not a precondition to consideration of an offer. Except when provided for by contract, deposited specimens must be accompanied by a letter or other document of conveyance signed by the donor and whenever possible by copies of any government permits required for their collection, culture, or transfer. LFL will acknowledge receipt of specimens and its willingness to accept, accession, and maintain them as part of the LFL Collection. Material contributed without funds for initial curation may be accessioned, stored, and minimally maintained until LFL is otherwise able to cover those costs.

Contributed specimens must be adequately labeled and, whenever possible, accompanied by corresponding sets of collection and specimen data and associated documentation (e.g., copies of field notes, listings or computer databases of collection and specimen data, and copies of, or reference to, pertinent reports and publications). Collection data should include at least collection date, location, and if available, latitude and longitude or UTM coordinates. Specimen data should include at least taxon name and, if available, number of specimens and length information. Gift or exchange specimens received from other collections should be accompanied by copies of associated catalog records and other data maintained in regard to those specimens. Offers, documents of conveyance, related correspondence, and data submitted with contributed specimens are maintained in appropriate LFL Collection files.

Accessions—Accessioning is the formal process of adding a set of deposited collections to LFL Collection holdings. It is accomplished by (1) assigning a unique accession number to the set (the current or next available date in the form of year-Roman numeral month-day, e.g., 1996-IV -24), (2) entering that number and selected information about the set of collections (source and responsible contact; description of where, how, when, why and by whom the set of collections was taken; and the number of collections, lots, and specimens) in the LFL Collection Accessions Log (a dBase file, accesslg.dbf, and printed version thereof), and (3) establishing a file of data and documents associated with that set of collections. LFL maintains two categories of accessioned collections, cataloged collections and backlog collections, the latter of which are minimally maintained until they can be cataloged. The accession number is used to identify the file of collection-related data and set of collections even after they have been cataloged.

Authority over Specimens—LFL assumes full, unencumbered authority on behalf of the public for the disposition and use of specimens deposited with or permanently transferred to the LFL Collection, with the following exceptions. LFL will recognize and accommodate

agencies or researchers requiring continued authority over the destructive use or permanent transfer of specimens they contribute to the LFL Collection, as well as their right to withdraw or transfer that material elsewhere, so long as they adequately cover the one-time costs of adding their specimens to the cataloged collection and the annual costs for their subsequent maintenance and management. LFL employees retain similar authority over contributions from their personal reference collections during their employment at LFL's expense. Destructive use or permanent transfer of specimens maintained under a depositor's authority is allowed only with written authorization by that contributor. A Research contract that specifies destructive use or permanent transfer of specimens over which the contractor maintains authority is considered written authorization. The LFL Collection Curator may appeal to an authorizing depositor for reconsideration of destructive use or transfer of specimens that might not be in the best interests of science or the public. Costs for permanent transfers of deposited specimens requested or authorized by a depositor maintaining authority over those specimens must be covered by that donor or the recipient institution. Such costs include documentation of deaccessions in the LFL's Collection catalog, preparation of transfer invoices and copies of related data files, and handling and shipping of specimens and related files.

Specimens in very poor or mutilated condition that do not represent rare or unusual species, distributions, or conditions and are maintained under LFL's full authority may be discarded by the curator. Similar specimens maintained under a donor's authority may be discarded only with the written approval or request of the contributor. Non-fish organisms included with deposited collections (usually incidental captures) are transferred to other interested collections, researchers, or educators when such can be conveniently arranged; otherwise they may be discarded at the discretion of the curator. Specimen discards or transfers are appropriately documented in LFL Collection files and if fish, are formally deaccessioned in the accession log. Discards or transfers of fish from the cataloged collection are also recorded as deaccessioned in the catalog.

Cataloging, Maintenance, and Management of Collection

LFL strives to achieve professional standards in the care and management of its collection. Most specimens are stored on specially constructed wooden shelving near LFL offices and laboratory in Room 33 of the J.V.K. Wagar Building on the main campus of Colorado State University. The storage area is well ventilated, temperature-controlled (generally 65-70 C), generally shaded from excessive lighting of any kind, and not exposed to direct sunlight.

Cataloging—A taxon-specific lot of specimens is formally added to the LFL's cataloged collection by assigning it the next available catalog number, entering pertinent collecting event and specimen data in the catalog, relabeling the lot with standard LFL Collection labels, and placing the lot in its appropriate location on collection shelving. Whole specimens, or parts thereof (e.g., scales, otoliths, fin-ray sections, digestive tract contents) that are not stored in fluid are labeled and cataloged according to their preparation. Priority for cataloging goes to specimens for which funds are specifically available for that purpose through the depositing agency or other grants or contracts. Remaining LFL holdings are considered backlog and cataloged as time and LFL resources allow. Specimens in collections

analyzed by LFL, and which are to be subsequently maintained by LFL, are usually cataloged as part of collection processing.

Some public agencies which retain authority over collections held and managed by LFL (e.g., National Park Service) require that their specimens also be assigned numbers in their own collection catalog, their numbers be appropriately cross-referenced in the LFL catalog, and LFL catalog data be provided to them for inclusion in their catalog or files. Such requirements are usually attended to after the specimens are cataloged by LFL.

Maintenance—Cataloged, fluid-preserved specimens are maintained as taxon-specific lots (usually species) in standardized containers and preservatives with standardized wet labels and are systematically organized on LFL shelving for easy access as voucher, study, or reference collections. Lot containers have been standardized to 20-ml glass scintillation vials with Polyseal™ caps, and 2, 8, and 16-oz (~60, 237, and 473 ml, respectively) straight-sided jars (83, 134, and 147-mm tall, respectively) with special Teflon-lined lids. These containers facilitate organization on shelving and minimize evaporative losses. To conserve shelf space, vials are stored separately from larger containers in 50 or 100-cell trays which are stacked two high on shelves proximal to larger containers. Containers larger than 16 oz are avoided, but when required they are stored on more-widely spaced shelves to accommodate their greater height. In some cases individual lots are stored in more than one container to conserve preservative and space (e.g., two vials instead of a 2-oz jar). The number and size of containers for each lot are recorded in the primary records of the LFL Collection Catalog and the lower left corner of each container label. Cataloged collection labels (Figure 1) are laser-printed on high-quality, linen or cotton fiber paper (e.g., 28# Byron-Weston Resistall) and cut to about 33 x 51 mm to accommodate our smallest containers (20-ml vials).

LFL 2725 Catostomidae: 14		LFL 13153 Cyprinidae: 15		LFL 22334 Cyprinidae: 15	
<i>Xyrauchen texanus</i>		<i>Gila cypha</i> ?		<i>Ptychocheilus lucius</i>	
N = 2, 36.6-39.3 mmTL		N = 1, 16.4-16.4 mmTL		N = 7, 9.0-10.0 mmTL	
100% ethanol		3% buffered formalin		100% ethanol	
UDWR-G91NS1004B		FWS/GJ-85L-079		CDOW-94DR-L035	
North America, USA, Utah, Grand Co.		North America, USA, Utah, Grand Co.		North America, USA, Colorado, Mesa Co.	
Green River		Colorado River		Colorado River	
River Km: 89.5		Shoreline		LOMA	
Dev Int: JV		Id: LFL/1985		Dev Int: LR	
Id: Kevin Bestgen/91		26-JUL-1985		Id: LFL/1995	
30-JUL-1991		River Km: 181.4		12-JUL-1994	
Gear: seine		Gear: Fine mesh seine		Gear: Larval fish drift net	
V: 2-vials		V: 1-vial		V: 1-vial	
Larval Fish Laboratory, Colo. St. Univ.		Larval Fish Laboratory, Colo. St. Univ.		Larval Fish Laboratory, Colo. St. Univ.	

FIGURE 1.—Larval Fish Laboratory Collection labels.

LFL Collection specimens are maintained in a variety of preservatives. As collections are examined or cataloged, all formalin-preserved specimens are retained in or transferred to 3% phosphate-buffered formalin (Markle 1984, Snyder 1983) to reduce the hazards of working with collections in stronger formaldehyde solutions. Standard procedure for many ichthyological collections is to transfer formalin-fixed specimens, including larvae, to alcohol preservatives. However, LFL prefers to retain formalin-fixed specimens in dilute formalin to avoid the shrinkage and distortion of early life stages often caused by dehydration in alcohol preservatives. Specimens received in ethanol or isopropanol are retained in those alcohols, but concentrations are standardized to 70% or 95-100% for ethanol and 50% or 100% for

isopropanol. Specimens cleared and stained for skeletal study are maintained in 70% ethanol or 100% glycerol. Specimens received in special preservatives (e.g., glutaraldehyde, color preservatives) are maintained in those preservatives whenever practical. For cataloged collections, current preservative is recorded in the collection catalog and on lot labels. Unless the depositing agency reports otherwise, it is assumed that 95-100% alcohol-preserved specimens were fixed in that preservative and that formalin and lower-concentration alcohol-preserved specimens were initially fixed in 5-10% formalin. Significant deviation from these protocols, if known, documented as remarks in the collection catalog. Backlog collections are usually maintained in their initial preservative but if notably changed, such is documented on supplemental container labels and in associated collection files. Collection containers are filled as completely as practical with preservative to avoid drying of specimens and aid inspections for poorly sealed containers. All collections are checked annually for loss of preservative. Dried specimens, if kept, are usually maintained in that condition and so noted in associated collections files or the catalog. Specimens or parts thereof that are not maintained in fluid preservatives are maintained according to their preparation.

Voucher, Study, and Reference Collections—Voucher collections are preserved specimens usually collected at a specific location and time. As such, they represent a specific historical occurrence and irreplaceable sample of natural history. They are often taken as part of organized field investigations. When collections are readily identified and processed in the field, voucher collections may consist of only one or more specimens that vouch for each taxa and sometimes each developmental interval or age-group reported during that investigation. Unusual or questionable specimens are also typically preserved. However, when working with unfamiliar taxa or specimens that are difficult to identify and process alive in the field (e.g., early life stages of fish), collections are necessarily preserved for each site and time sampled. Sometimes voucher collections are an aggregate of specimens taken at different locations and times during an investigation; as such they no longer vouch for taxa (and life stages) taken during specific collecting events, but they still represent taxa reported to have been taken over the associated range of collection sites and dates. LFL voucher collections are stored on shelving according to container size (vials or a mix of larger containers) and ordered sequentially within those groupings by catalog number. When possible, all lots from the same voucher collection and all collections from the same investigation are cataloged and stored together (except for storage separation according to container size).

Study collections consist of preserved specimens that do not represent a historical, natural occurrence or for which such associated collection information has been lost. Such specimens may have been artificially reared, preserved during or at the conclusion of laboratory or field experiments, or selectively and permanently removed from voucher collections for morphological examination, descriptive study, or other educational or research purposes. If possible when study specimens are removed from voucher collections, links to source lots are maintained in the collection catalog.

Reference collections are usually specimens selected from voucher and (or) study collections that are conveniently organized to aid taxonomic identification by comparison with collected material. Again, if possible, links with source lots are maintained in the collection catalog. Study and reference collections are organized on shelving phylogenetically (by species) then by catalog number (except for separation according to container size).

Backlog Collections—Specimens that have not yet been cataloged are stored and sufficiently maintained to ensure that they remain adequately preserved and can be located when needed. If adequate for temporary storage, they are kept in their original containers and preservative with their original labels (as received). Some backlog collections may be stored in well-marked boxes rather than on shelves. Backlog collections are periodically inventoried to verify their continued presence and location.

Access and Use

The LFL Collection is held on behalf of the public and contributors for research, reference, and educational purposes, but access is controlled to protect sensitive information and rare specimens, assure appropriate use, and avoid unnecessary losses. All reasonable requests for non-destructive use of collections will be accommodated within LFL's legal, physical, and financial constraints, so long as the requesting user agrees to conditions stated below (Requests for Use) and has not previously violated those conditions. Priority among multiple requests for the same specimens is determined by the curator, who can request the early return of a loan to accommodate a subsequent request. Specimens separated from their original lot by users to serve as individual vouchers for their specimen-specific data are removed by the curator from the original catalog record and recataloged as a new, but still linked, lots. Policies regarding destructive use, gifts, and exchanges of LFL holdings are covered in separate sections below.

Collection Catalog Data—Information in LFL's computer-based collection catalog, a MUSE database (see "Documentation and Databases" section below), is available in several forms. The master catalog, which is located at subdirectory I:\LFL\MUSE on the Department of Fishery and Wildlife Biology local area network (LAN) can be accessed in read-only mode from any computer connected to the LAN (only authorized LFL staff have access for entering or editing records). Once in the MUSE subdirectory, the MUSE program is started by first entering "btr" which starts the Btrieve database engine, then entering "muse". To help navigate the program and browse or search the database, MUSE provides menus, displays of some function-key features, and on-line help (F1 key). More detailed instructions are available in a copy of the "MUSE Tutorial and Reference Manual" maintained by the curator. A printed, limited-field version of the catalog is maintained with the collection and is available for browsing by LFL visitors. Information on backlog collections must be requested directly from the curator.

Interested public with access to an Internet-connected computer from anywhere in the world can browse or search limited-field versions of the catalog through the (World-Wide) Web or Gopher. To access the LFL and other fish-collection catalogs on the Web, users should open their Web browser (e.g., Mosaic, NetScape) to the Biodiversity and Biological Collections Server at <http://muse.bio.cornell.edu>. From there they must select "Ichthyology", then "Query On-line Fish Database" which takes them to "Fish Searches." Alternatively, they can open directly to "Fish Searches" at <http://muse.bio.cornell.edu/taxonomy/fishsearch.html>. Once on the "Fish Searches" page, options are: (1) query by example using taxonomy and geography, (2) query by catalog number or field number, (3) query by species with map-based output, or (4) query using hierarchical classification (beginning at class or subclass level and working down to species and individual records). For persons with a Web browser

that can't handle forms or who prefer a WAIS-type Gopher search (any word or combination in available fields), options for Gopher searches are also available at this Web site. Gopher users should connect directly with the Biodiversity and Biological Collections Gopher site (muse.bio.cornell.edu) and select "FishGopher." For some endangered or sensitive species records, precise collection locality information may be deleted in the on-line versions of the LFL catalog.

Requests for Use—Requests for use of specimens in LFL facilities or by loan must be submitted in writing to the curator. They should be submitted in advance of a visit, but can be submitted and acted upon during a visit if circumstances permit. An optional request form is available (Appendix I). Requests must include:

- name, affiliation, address, and telephone number of the user;
- which and how many lots or specimens the user wishes to examine;
- the purpose for use of collection material;
- where, when, and how long the requester would like to use it; and
- dated signature of the requesting user.

Requests for loans must also include:

- specifically where and how the borrower will store loaned specimens;
- name, address, and telephone number of a supervisor or associate (advisor or curator if the borrower is a student) who will be responsible for return of the loan in event the borrower is unable; and
- dated signature of the willing supervisor or associate.

In some cases, additional information or conditions may be required.

Approved requests will be marked as such, dated and signed by the curator, and a copy placed in LFL files. Original copies of approved requests will be returned to the user with a "Conditions of LFL Collection Use Agreement" (below and Appendix I) which must be read, agreed to by dated signature, and returned to the curator before use of LFL specimens will be allowed. Requests may be rejected if:

- the purpose is deemed an inappropriate use of collection material;
- use would unnecessarily damage or alter specimens;
- there is unacceptable risk of loss or damage to specimens, especially those representing endangered species, rare occurrences, or taxa that are poorly represented for LFL holdings; or
- the requester has previously violated LFL conditions of use or has a poor history of specimen use in other collections.

Rejections may be appealed to the LFL Director for joint reconsideration by LFL's senior staff.

Requests for use of backlog (uncataloged) specimens will be accommodated whenever possible. However, at the curator's discretion, such specimens will usually be cataloged before they are released to provide the requesting user with formal catalog numbers for inclusion with his data, reports, and publications.

Conditions of Use—Except as necessary for approved destructive uses, users of LFL Collection specimens must agree to and sign a form (Appendix II) listing the following conditions of use:

- (1) All LFL Collection specimens will be handled so as to preclude the possibility of mistakenly returning specimens to the wrong lots or containers.
- (2) When removed from lot or shipping containers, specimens will be maintained in similar preservative and except momentarily during transfer or examination, must not be allowed to dry. Formalin-preserved specimens, however, may be transferred to water for short periods during examination (no more than an hour), then returned to formalin preservative as soon as possible to prevent reversal of tissue fixation.
- (3) Specimens will be handled carefully using implements least likely to cause handling damage. Flexible, blunt-pointed forceps and wide-mouth pipettes or droppers are especially recommended for handling small, fragile fish eggs and larvae.
- (4) Specimens will not be subjected to freezing temperatures or excessive heat or light either in storage or during examination (e.g., exposed to microscope lighting longer than necessary).
- (5) Accidental losses of or incidental damage to specimens will be documented on supplementary container labels and reported in a letter or memo to the curator; this provision is required to assure proper documentation of changes in lot contents and specimen condition.
- (6) Preservative in lot or associated containers will be replenished or replaced (topped-off) with like fluids as needed.
- (7) Specimens used within LFL facilities will be returned in their original lot containers and replaced in their appropriate locations on collection shelving; similarly, borrowed specimens will returned to LFL in their original loan containers. Exceptions are specimens which must be maintained separate containers to readily distinguish them from the remainder of the lot (e.g., specimens were misidentified, have unusual characteristics, or are now the unique source for specimen-specific data). When such separations are necessary, both the original lot or loan container and the new containers must be labeled with appropriate annotations and the source catalog number.
- (8) Copies of specimen-specific or lot-specific data and images generated by the user (e.g., meristic counts, morphometrics, age, digestive tract contents, parasites, anomalies, photographs, drawings) will be provided to LFL for inclusion, with acknowledgement of source, in related LFL Collection files and updates to the collection catalog. (Except for data included in the collection catalog, user data and images will not be released or used by LFL prior to its publication without the user's permission.
- (9) Use of LFL Collection specimens or data will be appropriately acknowledged in any report, publication, or database including information from the collection catalog.
- (10) Copies of reports, publications, or relevant portions thereof that are based at least in part on LFL Collection information or specimens will be contributed to LFL for inclusion in its library and appropriate citation in the collection catalog and appropriate collections files.

Documentation of Use—Requests, approvals, and conditions-of-use agreements are necessary documents maintained in LFL files for protection of the collection, LFL, and users.

Visitor Use—LFL prefers that collections be used within the confines of its own facilities. The laboratory includes several workstations that are available to visitors when they are not in use by LFL staff. Advance arrangements must be made with LFL staff for extensive use of LFL facilities. Visitors to LFL, regardless of purpose, are asked to sign a guest register and note the date, their affiliation and address, and their purpose.

Loans—When on-site use of specimens is impractical, LFL will consider requests for loans. Loans are generally approved for no more than a year at a time, but requests for extensions or renewals will be considered. Failure to return loans on or before their due date can result in rejection of future requests for collection use. In all cases, LFL reserves the right to prematurely recall loans if the curator determines there is a greater immediate need for that material by another researcher or if there is cause for concern about the safety and care of loaned material.

Each loan is accompanied by two copies of an invoice that specifies the loaned material, pertinent catalog or collection data, any special conditions, and duration of the loan. The borrower is expected to immediately inventory and check the condition of material received, note any problems, and sign, date, and return one copy of the invoice. Documentation and management of loans and printing of invoices for the loan of cataloged material are handled through LFL's collection catalog and management system (custom version of MUSE). Similar documentation and invoices are prepared and filed for loans of backlog material.

Specimens are generally shipped with copies of their lot labels in well sealed plastic vials or bottles which are in turn packaged in a sturdy corrugated cardboard box to minimize chances of loss or damage. If glass containers are used, they must be especially well cushioned and packaged so as to prevent movement and glass to glass contact; they also may be secondarily sealed in heavy plastic bags in case of breakage. Specimens are to be similarly well packaged for return by the borrower. Especially valuable collections may be shipped one half at a time to reduce chances of loss. Collection material should be handled by a carrier that can ensure that it will not be exposed to freezing temperatures or excessive heat and that it will arrive at its destination within a reasonable period of time. U.S. Postal Service, library rate is often adequate. Shipments should be insured (minimal amount) to facilitate tracking if a shipment becomes lost in transit. International loans may be subject to special forms and permits.

Specimens borrowed by LFL staff from other collections will be treated according to the same policies for use except as alternatively required by the lender.

User Costs—When collection use requires more than an hour of assistance, shipping and handling time, or more than four hours of LFL facilities use for the same project, LFL may require compensation at its standard rate for taxonomic services by senior staff. LFL may also request borrower reimbursement for shipping costs that they exceed \$10. Exceptions to these fees may be provided for in contracts with LFL. Agreement to cover these costs may be an additional condition for use of LFL Collection specimens.

Destructive Sampling

LFL seeks to minimize destruction or alteration of preserved specimens but recognizes that such is sometimes the only practical means for acquiring certain types of information. Requests for destructive or specimen-altering uses may be rejected when alternative, less destructive techniques are available for acquiring the desired information or when the proposed use involves rare or endangered species, specimens representing rare occurrences, or taxa or life stages that are poorly represented in the LFL Collection. For specimens retained under the authority of depositing agencies or persons, written permission by a responsible representative of that agency or that person must be obtained before requests for their destructive use can be approved.

In the selection of specimens for destructive uses, LFL will avoid sacrificing all available specimens of a taxon from a specific collecting event. For most experimental or educational purposes requiring destructive techniques, specimens are selected from taxa and life stages in plentiful supply, preferably from study collections. Tissue extracted for DNA, RNA, and other molecular analyses should be taken in the smallest practical quantity and, when possible, using tissues of least diagnostic or morphological interest on the right side of the fish.

Except as otherwise approved by the curator, specimens that have been cleared and stained for examination of internal structures, partially dissected, or otherwise altered are to be returned with any excised body parts (e.g., digestive tracts and contents; pharyngeal teeth, otoliths, scales) to the LFL curator for future re-examination or additional study. Altered specimens should not be returned to their original lot, but rather stored individually or in groups (when size or other characters sufficiently differentiate them) in separate containers with appropriate preservatives and well annotated labels. When possible, excised body parts should be stored together with the specimens from which they were removed. Small capsules or vials can be used inside individual specimen containers to hold very small body parts, gut contents, or parasites. Excised parts such as pharyngeal teeth should be returned to their proper location in the body if they can be adequately held in place. Sometimes excised body parts must be permanently mounted or otherwise prepared and maintained independent of the remainder of the specimen. Labels prepared by the user for new specimen containers or special preparations must include the original lot catalog number and designations linking individual specimens and any separately prepared parts to each other as well as to associated data, illustrations, or images. Unused or unaltered specimens should be returned to their original lot or loan containers with supplemental labels indicating how many specimens were removed to other containers or preparations and a list of user designations identifying those individual specimens and the recorded data derived from them. With prior approval by the curator, specimen remains that are not likely to retain sufficient value to warrant continued curation may be discarded. All changes in specimen counts, preservation, preparation, condition, and storage, including their excised parts, must be documented on return-loan invoices or memoranda and submitted to the curator along with copies of associated data and illustrative material extracted from those specimens.

After acknowledgement of receipt of borrowed or used-on-site collections and associated documentation involving changes discussed above, the curator makes appropriate deaccessions, other changes in original catalog records, labels, and collection files, and recatalogs displaced specimens or the parts thereof under new, but linked, catalog numbers.

Appropriate remarks are appended to both original and new records to help trace these changes and note the existence of new user data in LFL Collection files.

Gifts and Exchanges

LFL recognizes that when numerous specimens are available representing a specific taxon and collecting event or set of collecting events, it may be prudent to transfer some of those specimens or lots, as gifts or exchanges, to other institutions or organizations maintaining recognized ichthyological collections. Such transfers should expand the taxonomic and life-stage coverage of recipient collections and make those specimens more readily accessible to potential users and students in that collection's locale. Gifts and exchanges can also ensure survival of some representative taxa and life stages from specific collecting events or programs should catastrophe befall the contributing collection.

Gifts or exchanges are negotiated on LFL's behalf by the curator. When possible transfers should be exchanges designed to mutually benefit the diversity of taxa and life stages held by both collections. Transfers of LFL specimens for which the collectors retain ultimate authority must be approved by the collecting agencies or researchers. Copies of associated catalog data and collection files are transferred with the specimens.

Gifts and exchanges are handled in a manner similar to loans and accompanied by similar invoices. Documents of transfer are maintained in appropriate LFL files and deaccessions are managed in the LFL Collection Catalog with remarks including the nature of the transfer, the recipient collection, and its accession and catalog numbers for the transferred specimens.

Documentation and Databases

LFL maintains a computer-based collection catalog and management system for its cataloged collections and files of collection-related data for both cataloged and backlog holdings. Collection files include LFL, user, or collector-generated data and images, requests for use, "Conditions for Collections Use Agreements", loan and transfer invoices, related correspondence, and copies of or references to pertinent reports and publications for current and past holdings. Data in those files remain the intellectual property of the researchers or agencies that generated it; public access to and use of that data prior to its inclusion in a final report or formal publication requires source approval. All publication or presentation of data obtained in LFL Collection files should properly acknowledge both the original source of the data and the LFL Collection.

Collection Catalog and Management System—Collections are cataloged, updated, and managed with regard to loans, gifts, exchanges, and deaccessions through LFL's customized version of the MUSE database management system for natural history collections (Humphries 1994). With National Science Foundation support, MUSE was originally developed for ichthyological collections by Dr. Julian Humphries and associates (Cornell University) using Novell's network-compatible Btrieve database engine. However, it has since been adapted for a wide range of museum collections from vertebrates in general to mammal, bird, herp, invertebrate, and even botanical collections. MUSE is licensed for over 80 museum and research collections in North America, South America, and overseas, including many of the

more widely recognized fish and herpetological collections. Although MUSE is customized to the special needs of each individual collection, all versions are based on a standardized database model for preserved biological collections. This allows collection catalogs that have been linked to a specially configured MUSEServer to be searched individually or simultaneously from any computer connected to the Internet (see above under "Access and Use—Collection Catalog Data").

MUSE catalog data are maintained in two relational database files, "primary.dat" and "locality.dat". Primary records include specimen or taxon-lot data such as taxon identity (usually species), number of specimens, and size, whereas locality records cover where, when, how, and by whom the specimens were collected (Figure 2, Appendix II). Each primary record is assigned a unique sequential "catalog number" and each locality record a unique "field number." All primary records for taxa from the same collection are related to the same locality record by "field number." Each primary record is also linked by taxon name to taxonomic dictionaries (other relational files) that ensure valid and properly spelled names. A special MUSE utility called CLIO facilitates taxonomic queries of the catalog at all major taxonomic levels (e.g., order, family, genus, or species). Changes or corrections to the identity of specimens in primary records are tracked in a linked taxonomic history file. The loan status of specimens is automatically updated in primary records whenever changes are made to loan records.

Descriptions of MUSE database fields; procedures for entering, editing, and browsing data; printing labels, invoices, and other documents; and processing loans, returns, transfers, and deaccessions are detailed in the "MUSE Tutorial and Reference Manual" (Humphries 1994). The "MUSE Utilities Reference Manual" (Humphries 1994?) provides instructions for the use of CLIO and other special utilities for testing, repairing, searching, and outputting MUSE files. Copies of both documents are maintained by the LFL Collection curator. They may also be downloaded from the Biodiversity and Biological Collections Web Server (<http://muse.bio.cornell.edu/muse/musepdf.html>). Appendix II is a list of MUSE, modified, and special primary and locality database fields used in the LFL Collection Catalog with descriptions of the data to be entered therein.

Notable limitations of the MUSE program are difficulty in uploading batches of data already present in other databases (e.g., dBase) and limited built-in querying capabilities. The numerous data checks and field-content specifications in MUSE make batch uploads from ASCII or other databases potentially hazardous. MUSE Project staff strongly recommend keyboard entry of catalog data but will assist when batch data uploads are necessary. Within MUSE, users can conduct single-field searches of primary records by catalog number, (taxonomic) group number, genus, species, or field number; locality records can be searched by field number, country, state, county, and date. For complex queries, searches of non-indexed fields, and convenient summaries and reports, MUSE requires a separate database querying and reporting program. Some of these programs can directly access Btrieve data files (e.g., Xtrieve, Crystal Reports, Access); others require uploads of delimited ASCII output from MUSE (e.g., dBase, Paradox). Although much less convenient than a program that directly accesses Btrieve files, LFL periodically uploads most of its MUSE primary and locality data to corresponding dBase files for queries and database summaries not possible within MUSE or through special MUSE utilities. Remarks fields, because of their large size, are treated as separate but linked dBase files. The resulting dBase primary.dbf, locality dbf, and lremarks.dbf (locality remarks) files are linked by "fieldnum", and primary dbf and


```

===== LFL - MUSE VERSION 3.5.0 =====
F1=Help F4=Ditto F5=Clear Line F7=Del rec PgUp=Prv rec PgDn=Nxt rec ESC=Exit
< Primary > - Edit
Catalog #:      12345                      Field #:  FWS/GJ-86L-025
Genus:          Rhinichthys                Group #:  15
Species:        osculus
Subspecies:
Determiner/yr:  LFL/1986                  Questionable?  N
Storage:        V:1-vial                  Cataloger/yr:  DLM/1995
Fluid Count:    5      Other Count:  0      Previous #:
Preservative:   3% buffered formalin      C&S Count:    0
Preparation:
Min. Size:      9.5    Max. Size:   19.0    TL/SL:  TL
Devel. Int.     -----                  Age:    0
Type Status:
Tax. History?   N                      On Loan?  N
Inventory:      F      De-accessioned? N
Remarks:       TL LF 10mm:  L5-1, L15-4
Last Mod: 17-FEB-1995

PR FM PM MT JV AD LR, +"Y" for yolk-bearing (PRY)

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===== LFL - MUSE VERSION 3.5.0 =====
F1=Help F4=Ditto F5=Clear Line F7=Del rec PgUp=Prv rec PgDn=Nxt rec ESC=Exit
< Locality > - Edit
Acces. Date:    1995-II -16                Field #:  FWS/GJ-86L-025
Ocean/Cont:     North America
Country:        USA
State:          Colorado                   County:  Mesa
Water Body:     Gunnison River              River Km:  1.1
Locality:
Latitude:       ? ' ? ' "      Longitude:  ? ' ? ' "
Salinity:       F              Temperature:
Depth Water:    Shallow        Depth Capt:  Shallow
Gear:           Fine mesh seine
Collectors:
Date:           24-JUL-1986          Time:  -----  Last Mod: 16-FEB-1995
Remarks:       River Mile 0.7

Use 24-hour clock

```

FIGURE 2.—Larval Fish Laboratory version of MUSE computer-catalog data-entry forms; primary (taxon-lot) form on top and locality (collection) form on bottom. Prompts for active fields (i.e., for "Devel. Int." and "Time" in above examples) are provided in the lower-left corner of the screen. See Appendix II for descriptions of fields.

premarks.dbf (primary remarks) files by "catalognum." Field names for the dBase files are modifications of corresponding MUSE field names listed in Appendix II. The dBase program is used by LFL and many of its clients for recording, storing, transmitting, and summarizing processed collection data. A new Windows-based version of MUSE (renamed Zoe) will switch to the Microsoft Access database engine and is scheduled for release later in 1996. It should provide more complete and flexible querying and reporting capabilities and make batch uploads of data into MUSE catalogs safer and easier.

Backups—The master LFL Collection Catalog is maintained on the Department of Fishery and Wildlife Biology LAN (I:\LFL\MUSE) with backup copies on the hard-drives of selected LFL computers and tape. Only LFL senior staff and designated collection personnel have access to the master catalog for entering new or editing existing records. The above section entitled "Access and Use—Collection Catalog Data" discusses public, read-only access to the master catalog and limited-field electronic and printed versions thereof. If requested by the source agency, sensitive data such as precise localities for endangered species can be restricted from public access in the online version of the catalog. The dBase files noted above and a limited-field, printed version of the catalog are periodically updated and maintained with the LFL Collection. Duplicates of both the dBase files and printed catalog are maintained in RIP's database repository, U.S. Fish and Wildlife Service, Grand Junction, Colorado.

Data Checks and Corrections—All data entered in the LFL Collection Catalog are proofed for transcription or entry errors. Locality data for deposited collections are provided by the source agency or researcher, as are specimen data for collections not processed by LFL. For most collections processed by LFL, identities are verified by a second trained technician or taxonomist and counts are double checked. Identities of rare or endangered species or specimens of unusual form are verified by LFL or outside taxonomists. Data or specimen identities which are questioned, corrected, or refined by users are re-examined by LFL taxonomists and if warranted changed accordingly in LFL's catalog and files.

Ethics

LFL staff are subject to the ethical policies and codes of the department, college, and university through which we are employed, including pertinent guidelines issued by the university's Animal Care and Use Committee. Staff, visitors, and users of the LFL Collection are responsible for helping to assure the integrity and appropriate care of collection specimens and associated data as a valuable public resource. To avoid the appearance or possibility of improprieties, no fish specimens collected and preserved through LFL projects or deposited with the LFL Collection by outside sources may be transferred to the personal collections of LFL employees. However, once employment is terminated, former LFL employees, like any outside researcher, agency, or institution, can request loans, gifts, or exchanges of specimens for research, reference, or educational purposes.

Health, Safety, Hazardous Wastes, and Emergencies

LFL strives to provide a safe working environment for its staff and visitors and is subject to university, state, and federal health, safety, and hazardous waste policies and regulations, mostly in accord with guidelines of the university's Environmental Health Services program. We continue to seek support for improvements in collection storage that will facilitate better access and guard against the hazards of fire, earthquake, and accidents. LFL and its collection are housed in rooms with an overhead fire sprinkler system. Fire extinguishers are maintained by the university within and just outside LFL facilities and a manual alarm is positioned in the hall leading to those facilities. Procedures for reporting emergency situations are posted near a telephone just inside the entrance to LFL facilities. Recognizing the hazards of working with formaldehyde, alcohols, and other substances used in the preparation and storage of collection specimens, LFL and the university try to assure adequate ventilation of both work and specimen-storage areas. A double sink with exhaust hood and partially enclosed work stations with exhaust vents are provided for work with specimens in preservative. Waste preservatives are stored in 5-gallon containers which are regularly exchanged with empty containers by the university Environmental Health Services for recycling or incineration. LFL also provides gloves and barrier hand cremes for employee use, emergency formaldehyde respirators, and a portable air filtering machine designed to scavenge formaldehyde fumes in the event of formalin spills. A basic first-aid kit and eye-wash bottle are maintained in a central location for employee and visitor use. LFL employees and visitors have a mutual responsibility to themselves, others, and the LFL Collection to act in a safe and responsible manner with specimens, preservatives, and hazardous materials and situations. LFL senior staff will address and respond as soon as possible to unsafe, unhealthy, or potentially hazardous situations brought to their attention.

Disposition of Orphaned Collections

LFL seeks agreements with depositing agencies, other collections maintained on the campus, organizations concerned with natural history collections, and permanent regional and national ichthyological collections to help ensure the proper care and permanency of its collections. Such agreements should include arrangements for transfer of LFL Collection specimens to one or more permanent ichthyological collections should LFL no longer be able to adequately maintain its holdings and provide public access to them. In the event LFL can no longer physically or financially maintain and manage the collections under its care, the curator, other LFL staff, or an appropriate representative of the Department of Fishery and Wildlife Biology will carry out prior arrangements for specimen transfer or, in the absence of such agreements, seek alternative collections willing to assume curatorial responsibility. In such an event, collections maintained by LFL that remain under the authority of contributing agencies, will be returned to those agencies or transferred to an alternative collection with which those agencies are able to make suitable arrangements.

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- Markle, D. F. 1984. Phosphate buffered formalin for long-term preservation of formalin-fixed ichthyoplankton. *Copeia* 1984:525-528.
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Appendix I: Draft Strategic Plan for the LFL Collection

LFL seeks the formal organization, recognition, and support necessary to improve maintenance, use, and permanency of the preserved specimens entrusted to it. To this end, LFL more specifically seeks support to:

- I. Provide part-time salary support for the curator and a collection manager to assist in maintaining the LFL Collection and providing public access to those specimens.
- II. Improve storage and care of holdings.
 - A. Provide sturdy trays for 2, 8, and 16-oz containers to reduce chances of containers being accidentally knocked off open shelving and make containers more accessible. (With such trays, it should not be necessary to add shelf lips, bars, or wires to restrain shelf contents.)
 - B. Anchor collection shelving units to each other and walls, as appropriate, to keep them upright in the event of accidents or earthquake.
 - C. Reinforce wooden shelves to prevent bowing and provide better support for stored collections.
 - D. Conveniently relocate or secure additional space and shelving to accommodate a rapidly expanding collection in a stable, temperature-controlled (preferably 15-20°C), light-protected, environment with provisions to minimize losses due to fire, flood, or earthquake and adequately vent formalin, alcohol, or other preservative fumes.
- III. Establish and implement formal accessions procedures.
- IV. Gradually catalog remaining backlog collections, upgrade their containers and preservative as necessary, relabel, and reorganize them on collection shelving or arrange for their transfer to a permanent collection willing to accept, catalog, and properly care for them.
- V. Improve online access to LFL Collection Catalog data to include the latest entries, updates, and corrections.
- VI. Expand the usefulness of the LFL Collection for taxonomic reference, study, and education through more comprehensive representation of the early life stages (especially larvae) of North American freshwater and anadromous fishes.
 - A. Solicit contributions or exchanges for taxa and life stages not well represented in the LFL Collection.
 - B. Collect or rear the early life stages of taxa not well represented in the LFL Collection.
- VII. Assure collection permanency.
 - A. Establish university recognition and support of the LFL Collection.
 - B. Establish formal agreements with more permanent ichthyological collections to ensure continued care and access in the event LFL is no longer able.

Appendix II: Collection Related Forms

Request to Examine or Study LFL Collection Specimens 20

Conditions of LFL Collection Use Agreement 21

Larval Fish Laboratory

Department of Fishery and Wildlife Biology
Fort Collins, Colorado 80523
(303) 491-5295, FAX 491-5091



To: Darrel E. Snyder, LFL Collections Curator

MEMORANDUM

From:

Date:

(name, affiliation, address, phone)

Subject: Request to examine or study
Collections specimens.

LFL Pages:

Which and how many specimens or lots?

For what purpose?

Where, when, and for how long?

If this is a loan request:
Specifically where and how will the specimens be stored?

Who will be responsible for return of the specimens if you are unable (name, address, and telephone number of a willing curator, supervisor, academic advisor, or associate)?

Signature of thst responsible individual: _____

Date: _____

Requester signature: _____
Date: _____

Request Approved? _____ (Yes or No)

Curator's Signature: _____
Date: _____

Remarks or Special Conditions:

To: Darrel E. Snyder, LFL Collections Curator

MEMORANDUM

From:

Date:

(name, affiliation, address, phone)

**Subject: Conditions of LFL Collections Use
Agreement**

Pages: 2

Except as otherwise authorized by the LFL Collections Curator through approval of written requests for use of specimens or by LFL research contracts, users of LFL collections must assure LFL by signing this agreement that:

- (1) All LFL Collection specimens will be handled so as to preclude the possibility of mistakenly returning specimens to the wrong lots or containers.
- (2) When removed from lot or shipping containers, specimens will be maintained in similar preservative and except momentarily during transfer or examination, must not be allowed to dry. Formalin-preserved specimens, however, may be transferred to water for short periods during examination (no more than an hour), then returned to formalin preservative as soon as possible to prevent reversal of tissue fixation.
- (3) Specimens will be handled carefully using implements least likely to cause handling damage. Flexible, blunt-pointed forceps and wide-mouth pipettes or droppers are especially recommended for handling small, fragile fish eggs and larvae.
- (4) Specimens will not be subjected to freezing temperatures or excessive heat or light either in storage or during examination (e.g., exposed to microscope lighting longer than necessary).
- (5) Accidental losses of or incidental damage to specimens will be documented on supplementary container labels and reported in a letter or memo to the curator; this provision is required to assure proper documentation of changes in lot contents and specimen condition.
- (6) Preservative in lot or associated containers will be replenished or replaced (topped-off) with like fluids as needed.

- (7) Specimens used within LFL facilities will be returned in their original lot containers and replaced in their appropriate locations on collection shelving; similarly, borrowed specimens will returned to LFL in their original loan containers. Exceptions are specimens which must be maintained separate containers to readily distinguish them from the remainder of the lot (e.g., specimens were misidentified, have unusual characteristics, or are now the unique source for specimen-specific data). When such separations are necessary, both the original lot or loan container and the new containers must be labeled with appropriate annotations and the source catalog number.
- (8) Copies of specimen-specific or lot-specific data and images generated by the user (e.g., meristic counts, morphometrics, age, digestive tract contents, parasites, anomalies, photographs, drawings) will be provided to LFL for inclusion, with acknowledgement of source, in related LFL Collection files and updates to the collection catalog. (Except for data included in the collection catalog, user data and images will not be released or used by LFL prior to its publication without the user's permission.
- (9) Use of LFL Collection specimens or data will be appropriately acknowledged in any report, publication, or database including information from the collection catalog.
- (10) Copies of reports, publications, or relevant portions thereof that are based at least in part on LFL Collection information or specimens will be contributed to LFL for inclusion in its library and appropriate citation in the collection catalog and appropriate collections files.

User Signature: _____

Date: _____

Remarks:

Appendix III: LFL Collection Catalog Fields

LFL Collection Catalog fields (attributes) for "primary.dat" and "locality.dat" files with screen prompts, data types, field lengths (maximum number of character and spaces), and descriptions of intended field contents, limitations, and usage. Most fields, characteristics, and usage are standard parts of the MUSE database model; LFL additions and modifications are italicized. Similar, but modified field names and characteristics are used for corresponding dBase files (primary.dbf premarks.dbf, locality.dbf, and lremarks.dbf).

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
PRIMARY.DAT (taxonomic and lot or specimen-specific data file; one record per taxon-lot or specimen; each record is linked to a corresponding locality record by "field number"—primary records for all lots or specimens from the same collecting event are linked to the same locality record.):				
catalog_number	Catalog #:	integer	6	This number uniquely identifies a taxon-lot or specimen included in the cataloged portion of the LFL Collection and is used, in part, to physically organize the collection for ready access and reference individual lots in catalog and collection management records. It is a unique integer sequentially assigned from "1" in ascending order to each lot or specimen as it is entered into catalog. Pressing the Alt-F10 keys (F10 while holding the Alt) will automatically enter a number one unit higher than the highest catalog number currently in the catalog. MUSE will not proceed with record entry until a unique integer has been entered in this field. (For other collections requiring such, MUSE offers variations on this field utilizing decimals, alphanumerics, or ranges.)
field_number	Field #:	string	15	This number uniquely identifies the collection event or source for cataloged taxon-lots or specimens and links primary data records with locality records in the catalog. LFL usually creates a number consisting of a consistently used source abbreviation (collecting agency, program, or individual; e.g., CDOW, FWS/GJ, DES), year and, if appropriate, collection type or program symbol (e.g., 86L for 1986 larval fish), and a unique, often sequential, alpha-numeric collection number (e.g., 025 or GR17) either provided by the collector or assigned by LFL to link the locality record with corresponding field notes and (or) other collection data in LFL or source files. When lacking suitable information to create a meaningful field number, MUSE has adopted the practice of prefixing a "Z" to the catalog number if there is only one lot corresponding to that locality record (F2 key does this automatically) or a "Q" to a range of catalog numbers if more than one sequentially numbered lots are to be linked to the locality record (done manually). Except for catalog number, which must already be entered, MUSE will not proceed with record entry until a unique sequence of numbers and characters has been entered in this field. If the entry corresponds to an existing locality record, MUSE proceeds to the Genus field. If there is no corresponding locality record, MUSE brings up the entry screen for a new locality record which must be completed before proceeding with the primary record (see fields for locality records below).
genus	Genus:	string	24	Enter genus, if known; if not, enter formal family name, formal order name, or "Unidentified", as appropriate. When using the default primary data entry form, MUSE automatically checks validity of the name against a genus-family-group taxonomic dictionary and prompts the user for revision if the name does not exist as spelled. When using the optional binomial entry form, which provides for entry of this information or genus and species (and optionally subspecies) all in one step, all entries including the binomial names (genus and species, but not subspecies), are automatically checked against a hierarchical taxonomic dictionary (see MUSE manual regarding taxon entry on this form). MUSE automatically capitalizes the first letter entered in this field; all others are lower case.

Appendix III, LFL Collection Catalog Fields Continued.

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
species	Species:	string	24	Enter species portion of name, if known; "sp." if not. All entries in this field are automatically lower case. MUSE does not validate species names entered on the default primary data entry form; however, if entered with genus on the optional binomial entry form, both genus and species are automatically checked against entries in the hierarchical taxonomic dictionary. If using the binomial entry form and species is unknown, enter only the higher taxon name—MUSE will automatically enter "sp." in the species field of the actual database.
subspecies	Subspecies:	string	24	Enter subspecies, if known and generally accepted by ichthyologists; leave blank if not. On the binomial form, as noted above for genus and species, subspecies can be entered as the third part of a trinomial, but it is not automatically validated or spell checked. All entries in this field are automatically lower case.
group_number	Group #:	integer	2	Group number is a numerical grouping of taxa in some older ichthyological collections and usually corresponds to individual families but sometimes two or more related families. It is entered automatically from a genus-family-group taxonomic dictionary upon acceptance of the genus entry on either the default or binomial entry forms.
questionable	Questionable?	logical	1	"Y" for yes, "N" for no, <i>depending on the whether there is doubt about the taxonomic identity recorded in the genus, species, and subspecies fields. If labels and other printed forms are properly setup, a "Y" in this field will generate a question mark after the taxon designation. "N" is the default value. LFL uses this field to indicate doubt at the taxonomic level reported (e.g., if given as <i>Gila</i> sp., or even Unidentified sp., and there is no doubt at that level of identification, LFL's entry is "N"), whereas MUSE Project staff recommend entering "Y" whenever species is unknown or questionable. Accordingly, when using the optional binomial entry form, MUSE is configured to automatically change the entry to "Y" if no species is designated. In the latter case, if there is no doubt about the identity as recorded, entry must be manually changed back to "N".</i>
determiner	Determiner/yr:	string	25	Name(s) of person(s) or agency responsible for identifying or reidentifying specimens in the lot of record and, following a slash mark, the year in which they were identified or reidentified.
cataloger	Cataloger/yr:	string	8	Initials of LFL staff member entering the original catalog record and, following a slash, the year it was entered.
storage	Storage:	string	10	<i>This is a three-part entry that indicates where and how the lot is stored (e.g., "V:2-sm jar"). It begins with an initial for the type of collection ("V" for voucher, "S" for study, or "R" for reference collection), followed by a colon, the number of containers used, a dash, and finally the type and size of standard LFL Collection container(s)—"vial", "sm jar", "md jar", or "lg jar" corresponding to 20-mm vials and 2, 8, and 16-oz jars.</i>
previous_num	Previous #:	string	15	Previous collection acronym and catalog number if specimens were transferred from a previously cataloged LFL lot (e.g., specimens that have been reidentified, studied, or altered and require separation from original lot for separate identity or reference; LFL-23714) or from another cataloged collection as gift or exchange specimens (e.g., TVA-16002).

Appendix III, LFL Collection Catalog Fields Continued.

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
number_alch	Fluid Count:	integer	4	Number of specimens if stored in fluid preservative but not cleared and stained for skeletal characters. For any one record, an entry is made in only one of the three number or count fields since all specimens in a specific lot are preserved or prepared in the same way. Standard MUSE usage of this field assumes fluid preserved specimens are stored in alcohol. Number is automatically adjusted when a corresponding deaccession record is created.
number_skel	Other Count:	integer	2	Number of specimens, or specimens represented by parts thereof, that have not been cleared and stained for skeletal study but have been specially prepared in some way that requires other than fluid preservation (e.g., dry or mounted skeletons, permanent mounts of otoliths or scales). Standard MUSE usage of this field assumes specimens not stored in fluid or cleared and stained are dry skeletons; no provisions for alternative preparations. Number is automatically adjusted when a corresponding deaccession record is created.
number_CS	C&S Count:	integer	2	Number of specimens that have been cleared and stained for skeletal or other internal characters and are maintained in a fluid preservative. Number is automatically adjusted when a corresponding deaccession record is created.
preservative	Preservative:	string	20	Description of preservative (e.g., 3% buffered formalin, 100% ethanol, 50% isopropanol, 100% glycerol).
preparation	Preparation:	string	30	Description of special preparation (e.g., dry skeleton, permanent mount of otoliths).
min_size	Min. Size:	float	5	Standard or total length of single individual or in multiple specimens lots, length of smallest specimen, or lower end of smallest length-frequency size group in millimeters to nearest tenth when known; partial replacement for standard 16-character string field used in most versions of MUSE for recording size information.
max_size	Max. Size:	float	5	For multiple specimen lots, standard or total length of largest specimen, or upper end of largest length-frequency size group in millimeters to nearest tenth of when known; partial replacement for standard "size" field in MUSE.
tl_sl	TL/SL:	string	2	"TL" if min_size and max_size are total lengths, "SL" if standard lengths; partial replacement for standard "size" field in MUSE.
devel_interval	Devel. Int.	string	15	Abbreviations for developmental intervals represented (e.g., PRY,FMY,PM,MT?)—"EGG" for unfertilized eggs or for which embryos are not apparent, "EM" for embryos (in eggs or excised from eggs or females), "PR" for protolarvae, "FM" for flexion mesolarvae, "PM" for postflexion mesolarvae, "MS" for unspecified mesolarvae, "MT" for metalarvae, "LR" for unspecified larvae, "JV" for juveniles, "AD" for adults; plus "Y" for yolk-bearing specimens (e.g., PRY); plus "?" if and where doubtful.
age	Age:	string	10	Year class(es) (e.g., 0, 1, 1+?)—"0" for young-of-the-year, 1 for yearlings, 2 for two-year olds, etc. using January 1 as date of transition between year classes; plus "+" to indicate that year and older; plus "?" if and where doubtful.

Appendix III, LFL Collection Catalog Fields Continued.

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
type_status	Type Status:	string	14	Not used—description of type status if type specimens. LFL specimens that might be designated as type for a taxon are transferred to a more appropriate ichthyological collection that does maintain type specimens.
onloan	On Loan?	logical	1	Default is "N" for no. Automatically updated to "Y" for yes if a loan invoice including all or part of the lot is processed; automatically returned to "N" when loan records indicate all borrowed specimens have been returned and replaced in the collection.
taxhist	Tax. History?	logical	1	Default is "N". Automatically updated to "Y" when the lot is reidentified (a taxonomic history record of original data is created in primary edit mode when the F8 key is pressed prior to editing taxon name).
inventory	Inventory:	char	1	Default is "F" for found; should be set to "M" if upon inventorying collections, the lot is missing. "U" is for unknown inventory status (normal MUSE default) should be very rarely used for LFL collections.
deaccessioned	De-accessioned?	logical	1	Default is "N". Automatically updated to "Y" (and specimen numbers adjusted) when a corresponding deaccession record is created.
time_stamp	Last Mod:	date	11	Date is automatically set when the record is created and is updated whenever data in the record are subsequently changed.
primary_remarks	Remarks:	note	60	Any supplemental data or comments such as condition of the specimens, anomalies, changes in preparation or type of preservative, discrepancies. As standard procedure, LFL includes the names of project and specimen-specific dBase or other computer files that include similar or additional data for the subject specimens; also, author-year citations for publications/reports based in part on these specimens. LFL also notes length frequency distribution here if such information is available.

LOCALITY.DAT (collection data file including geographic, ecological, temporal, sampling, and collector information; one record per unique collection event; linked by "field number" to primary records for all taxon-lots or specimens taken in that collection event; locality records may be entered and exist independent of primary records, but not vice versa):

accession_date Acces. Date: string 12 Date the set of collections to which this specific collection belongs was entered into the accessions log and a physical LFL Collection file was established for copies of records and data associated with that set of collections. This date, in the form noted below, also serves as the accession number for that set of collections. For LFL backlog collections without prior accession records, this is the date the first locality record for that set of collections was entered in the collection catalog. Unlike other date fields, this field is actually a string or text field; the first four characters are the year followed by a dash, the next five characters allow space for a left-aligned, upper-case, Roman numeral representing the month, the 10th character is another dash, and the last two characters are day (e.g., 1996-IV -24).

Appendix III, LFL Collection Catalog Fields Continued.

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
field_number	Field #:	string	15	This number uniquely identifies each collection event or source for cataloged taxon-lots or specimens and links primary data records with locality records in the catalog. LFL usually creates a number with a consistently used source abbreviation (collecting agency, program, or individual; e.g., CDOW, FWS/GJ, DES), year and, if appropriate, collection type or program symbol (e.g., 86L for 1986 larval fish), and a unique, often sequential, alpha-numeric collection number (e.g., 025 or GR17) either provided by the collector or assigned by LFL to link the locality record with corresponding field notes and (or) other collection data in LFL or source files. When lacking suitable information to create a meaningful field number, MUSE has adopted the practice of prefixing a "Z" to the catalog number if there is only one lot corresponding to that locality record or a "Q" to a range of catalog numbers if more than one sequentially numbered lots is to be linked to the locality record. This is the only mandatory locality field; except for the optional accession date, MUSE will not proceed with locality record entry until a unique sequence of numbers and characters has been entered in this field. It is automatically copied from the first associated primary record when locality records are completed along with primary records (see field number above for primary records). In the latter case, MUSE will return to the incomplete primary record upon completion of the locality record. (In versions of MUSE for which field number is inappropriate, a "Site Name" field and date combination links primary and locality records.)
cont_ocean	Ocean/Cont:	string	20	Name of ocean or continent where collection was taken ("North America" for most LFL collections).
country	Country:	string	20	Name of country where collection was taken (USA for most LFL collections)
state	State:	string	20	Name of state or province where collection was taken.
county	County:	string	20	Name of county or parish where collection was taken.
water_body	Water Body:	string	30	Name of water body (spring, creek, river, lake, reservoir) where collection was taken.
river_km	River Km:	float	5	<i>If the water body is a river or stream with the collection location given in terms of river miles or river kilometers, enter river kilometer to nearest tenth (multiply river miles by 1.61 km/mi and note river mile in remarks). If river mile or kilometer measures begin at some location other than the mouth of the river or stream, specify the origin in remarks. LFL separates this information from the locality field to facilitate searches or filters of the database by river kilometer.</i>
locality	Locality:	string	59	More detailed description of locations (e.g., west shoreline, 150 m north of Rt 66 Bridge, near Newtown); <i>specific habitat description if remaining space allows (e.g., upper end of backwater).</i>
lat_degrees	Latitude:	integer	2	Latitude degrees.
lat_minutes	"	integer	2	Latitude minutes.
lat_seconds	'	integer	2	Latitude seconds.
lat_NS	"	char	1	Latitude, "N" or "S" of equator; "N" for most LFL collections.

Appendix III, LFL Collection Catalog Fields Continued.

Field Name	Screen Prompt	Type	Length	Content Description/Acceptable Entries/Comments
long_degrees	Longitude:	integer	3	Longitude degrees.
long_minutes	°	integer	2	Longitude minutes.
long_seconds	'	integer	2	Longitude seconds.
long_EW	"	char	1	Longitude "E" or "W" of the Prime Meridian; "W" for most LFL collections..
[legal	Legal Descr:	string	16	Legal description of location; not currently used by LFL.]
salinity	Salinity:	char	1	Enter general category, "F" for freshwater (low to no salinity), "M" for marine or seawater (near 35 ppt), or "B" for brackish (between, as in estuaries and some desert lakes).
temp	Temperature:	string	7	Water temperature or range in degrees Celsius at point and time of collection; record nearby temperatures in remarks.
depth_water	Depth Water:	string	12	<i>Depth of water or range of depths, surface to bottom, where collection was taken; either word description (e.g., shallow) or measured in meters.</i>
depth	Depth Capt:	string	12	Depth or range of depths of capture or collection from the surface; either word description (e.g., near surface) or measured in meters.
gear	Gear:	string	30	Description of gear used for collection.
collector	Collectors:	string	42	Names of collectors, initials plus last name spelled out when available. If the individuals responsible for collections are unknown, enter the name or acronym of the responsible agency or organization.
date	Date:	date	11	Date of collection or initial date in the case of multiple day collections (note duration or ending date in remarks).
time	Time:	string	9	Time when collection was taken based on 24 hr clock; enter at least the initial or beginning time before the dash and, if applicable, the finish time after the dash. When time represents a unit of effort, the difference between these times should be the duration of the collection.
time_stamp	Last Mod:	date	11	Date is automatically set when the record is created and is updated whenever data in the record are subsequently changed.
loc_remarks	Remarks:	note	60	Any supplemental data or comments regarding habitat sampled, weather, collecting conditions, flow or velocity, flowmeter readings, unusual observations, problems, or data discrepancies. As standard procedure, LFL includes the names of project and collection-specific dBase or other computer files that include similar or additional collection data.